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# PROFESSIONAL STANDARDS IN THE WELFARE STATE

A LIVELY chapter in Mr. R. Lewis and Mr. A. Maude's survey "The English Middle Classes", three years ago, discussed the position and problems of the professions in the society of to-day. That discussion has now been expanded into a full-length study*, written with the same charm as well as scholarship, and pervaded with wit, sometimes a little tinged with malice. It covers a wider field than the earlier book by Carr-Saunders and Wilson, to which it is a natural complement, glancing at the Church and the Armed Services, which they excluded. The detailed historical account which occupies the bulk of that book is the natural starting point for this new survey, which reviews and analyses the trends of the past two decades with a lucidity and vivacity that should commend it far outside the range of the widest definition of the professional classes to whom it, presumably, is primarily addressed.

To professional organizations, indeed, it offers a clear challenge; it sounds a ringing call to the humblest members of a profession to face the implications and responsibilities of a situation in which their position threatens to continue to deteriorate. No less it is a challenge to thought, and to action, on the part of all who are concerned about the effectiveness of our social, and indeed our industrial organizations, from a national as well as from a personal or professional point of view. The authors have the courage to ask questions that have hitherto been evaded; and the issues confronting us in shaping educational policy and social services, especially the national health services, are described frankly and realistically. Criticism is constructive as well as penetrating. The professional man, be he scientist or technologist or otherwise, is summoned to work much harder to strengthen an influence already waning, and, accepting the responsibilities and implications of what Mr. Lewis and Mr. Maude describe as an aristocracy of talent, to seek, personally and through his professional associations, to protect himself and defend his ideals.

Mr. Lewis and Mr. Maude unhesitatingly defend the professional ideal. They are convinced that it has an essential place in the world to-day, and that, in fact, the institutions of democracy and of social service cannot function unless the traditions and standards of professional men are respected and upheld. But they are equally clear as to the price that has to be paid; and loose claims to be regarded as a profession are analysed and rejected with a ruthlessness verging at times on contempt. The validity of the claim thus trenchantly analysed of some of the newer specialisms to be regarded as professions, leading to the consideration of the question of what is a profession, is one of the three major issues raised in the book. The second is that which arises through the increasing extent to which the State has become the client of the professional man. The implications of this position, the impact of

* Professional People. By Roy Lewis and Angus Maude. Pp. viii + 284. (London: Phoenix House, Ltd., 1952.) 18s. net.

nationalization and the position of what are termed the socialized professions—in Britain, medicine and dentistry, with the other auxiliaries of the National Health Service, such as opticians, pharmacists and nurses, and teaching and law—are reviewed in three successive chapters. The third issue is that of professional education. This is considered in close relation to the other problems and to the factors which may determine supply and demand for practitioners.

On the first question, Mr. Lewis and Mr. Maude reach no hard-and-fast definition of what constitutes a profession. They incline to accept that of the "Oxford English Dictionary" which Carr-Saunders and Wilson quoted with approval: "a vocation in which a professed knowledge of some department of learning or science is used in its application to the affairs of others or in the practice of an art founded upon it". Unlike Carr-Saunders and Wilson, they reject very firmly the claims of management or administration to be considered as a profession. Equally they question the conclusion that the control of business or industry is likely to pass into the hands of those marked by professional outlook. The business instinct, they remark, will remain indispensable, and the extent to which it is influenced by the professional ideal will depend on the extent to which management passes into the hands of those who also, whether as lawyers, scientists or technologists, accept loyalty to some professional tradition.

Nevertheless, the authors insist on the value to-day of the professional outlook or spirit, marked at least by some measure of personal integrity on the part of the practitioner and some relationship of trust between practitioner and client or employer. The vital issue to-day is the extent to which professional people can remain professional in this sense, in the face, on one hand, of what is essentially dilution and, on the other, of the increase of professional employment by the State. It is the free, rather than the controlled, professions which set the standard and justify professional prestige. "The moment that the state organises, trains, and employs all the members of a profession, we can no longer speak of it as a profession. We can only speak of a body of expert officials. Such officials might, or might not, have high standards of conduct—but those standards would depend on the state of society, not the professional spirit; and any freedom they enjoyed would be on sufferance from those who held power."

This was foreseen by Carr-Saunders and Wilson. In such circumstances the professional man can no longer find in his vocational organizations the permanent anchorage and shelter regarded as the prerequisite for independent professional service to society. We are thus led to the second main issue raised in this book. Here the picture painted of the frustrating and depressing effect of State service and nationalization on the professional spirit is profoundly disturbing. Sometimes the deterioration of standards is for the time being obscured or mitigated, as in the National Health Service, by the possibility of living on the tradition of the past. When that is no longer possible, Mr. Lewis and Mr. Maude clearly do not believe that the traditional professional attitudes and standards can be maintained.

The third, and related, problem is that of professional education. The State, Mr. Lewis and Mr. Maude point out, is in a hurry to get more and more experts: simultaneously it seeks to encourage them to get a better training, and to reduce the period of training to get qualified men from anywhere, anyhow; at the same time it is trying to curb rising costs. Bluntly and specifically they write (of the nursing profession): "The root cause of the trouble is, quite simply, that (unless all other professions and jobs for girls are to be further raided for recruits) there are not enough young women of adequate intelligence and education in the country to staff both the schools and the hospitals, at the present level of services provided, without lowering standards".

It is idle at this stage to indict those who, introducing the new national services, failed to heed the scriptural advice first to count their resources, nor do Mr. Lewis and Mr. Maude allow themselves to stray from the point. They emphasize the way in which professional education itself depends on the quality of primary and secondary education, and thus on our ability to maintain the standards of teaching at that level. They indicate some of the implications of the situation for the professional institutions and the universities, and there is forthright criticism of some professions, notably of the excessive specialization of engineering. They insist that the solution of the present problem of professional education depends, above all, on genuine interest and sacrifice on the part of the best and most highly paid members of the engineering and scientific professions. They must teach; and at the same time, throughout the field of professional training, teachers must be helped and encouraged to vary their employment between practical work and teaching.

This brief chapter on professional education has some biting remarks on professional organizations, particularly in regard to technological education; and it places the responsibility for the dangers into which professional education is drifting—both over-specialization and inadequacies in the supply of the right type of talent and character—fairly on professional people themselves, as members of learned institutions and universities. Personal sacrifice as well as clear thinking will be required, and the authors add that professional people will never solve these problems by sitting on government committees, for even to accept membership of one of these is to deny ultimate responsibility for action.

That the State is setting the professions tasks beyond their powers is the real danger; but it does not follow that those demands inevitably involve dilution and the lowering of standards. The demands are not likely to be checked merely in the interests of the professions; nevertheless, this book gives some convincing reasons why it is in the general interest to diminish the present strain on the Civil Service and certain professions, even at the cost of postponing further nationalization measures or developments in social welfare until resources are more commensurate with requirements. The lowering of standards can be

avoided if professional bodies will devise clear definitions of professional ideals and standards, and limit the maintenance of high standards to situations in which the nature of the work makes it really necessary.

We are not left in doubt as to what such a policy demands of professional institutions. Institutional 'stiffneckedness' alone, the authors remark, will not preserve the professional tradition; and even in teaching it may be possible to utilize the auxiliary 'technician' once the opposition to salary differentials for graduates is discarded—an opposition to which is attributed largely the decline in academic standards in grammar schools. To distinguish between technician and technologist, between strictly professional work and non-professional, whether administrative or of the ancillary technical type which can be done by a laboratory assistant or other trained technician, requires clear thinking. Such decisions must be taken by the professional institutions and none other, and they must equally take account of the legitimate aspirations of the technicians, providing means and opportunity for those who have the ability to qualify for the professional grade. It means ruthlessness, as well as a clear conception of the nature of a profession, in dealing with some of the newer claimants to that title; and, quite possibly, a good deal more flexibility, as well as internal reform, in some existing professions.

"Only the doctors themselves," remark Mr. Lewis and Mr. Maude, "can preserve the integrity of their own profession"; and fundamentally the maintenance of standards is thus linked with the question of the proper use of the professional man or expert. This further reminder to the administrator and legislator that the supply of brains and ability in Britain is strictly limited, and that much of it is at present being wasted on work that could be done by less-qualified people, is also a challenge to the professional institutions to give adequate thought to the means of eliminating such waste and to the implications of the growth of modern administration for their own members. It is a stern warning of what may follow if professional institutions, on the other hand, disregard such constructive work and responsibilities, and become preoccupied exclusively with their protective or purely economic functions.

These economic functions are not ignored in this book. On the contrary, full weight is given to the difficulties which the deterioration in the economic position of the professions place in the way of recruitment of men and women of the requisite ability. The primary problem is none the less that of maintaining standards where the nature of the work demands high professional standards, and that in itself plays its part in attracting men and women of the ability and character required. Paraphrasing a passage from a recent Croonian Lecture by Dr. T. F. Fox, which they quote with approval, Mr. Lewis and Mr. Maude maintain that a professional man is a practitioner first and an employee second and incidentally.

A main argument of this book is that the basis of professional life is the contract between practitioner and client—an essentially ethical relationship—and that this fiduciary and confidential relationship lies not merely at the heart of the great professions of medicine and law, and their derivatives, but also, by the power of example and co-practice in the same environment, at the heart of all professions. The body of private practitioners and consultants sets the tune for professional life; in the last resort, the devotion which characterizes the Civil servant and which might be regarded as the ethic appropriate to an age of 'socialized' professions and nationalized industries, is also very largely derived from the conduct of the free professions. Reasonably enough, the authors suggest that service and selflessness are founded ultimately more on direct personal relations—ties of honesty, trust, honour and loyalty—between a professional man and his client, as they have been practised over generations, than upon any natural or instinctive urge in man to serve the community under irksome restraints, with a load of responsibility and for limited rewards.

To preserve this personal responsibility to the client in the professions of law and medicine is regarded by Mr. Lewis and Mr. Maude as the primary task, and it has to be achieved within the framework of partly 'socialized' administration and finance. They insist, too, that financial freedom must go with professional freedom, and that the professions, like the universities, should so far as possible be free from Treasury dominance. Linked with this is the question of administration, particularly as presented by the dangers which the growth of centralized organizations offers to the survival of professional traditions. Here they comment briefly on the question of leadership from a novel angle; and a remark as to the possibility of administration becoming the happy hunting ground of the second-rate mind is a shrewd hit at some current discussions and theories.

Through this book blows a refreshing air of common sense. Its realism is inspiring and persuasive. It deals some shrewd blows, and may provoke some irritation, even anger. But the professions have been warned, and also shown that they have some effective replies if they have the courage to take the right action. They could, for example, well afford to ignore the charge that by upholding educational standards they are failing to provide the experts in the numbers required by the nation: they would do better to refute the charge by emphasizing the effect on quality, or by pointing to the present prodigious waste of professional talent in government departments and in nationalized industry. "Those who claim to possess something of vital importance to the community should be prepared, not only to state clearly what it is, but also to fight to preserve it for the community's good."

That challenge must be met by professional people with vision as well as energy and courage. The book under discussion indicates also some of the steps that could be taken by professional people to adapt their institutions, both for the preservation of professional traditions and standards and for the more effective discharge of their professional functions and responsibilities to their clients, and to the society in which both client and profession have a vital part to play.

## HISTORY OF GEOLOGY IN GREAT BRITAIN

### Geological Survey of Great Britain

By Sir Edward Bailey. Pp. xii+278+4 plates. (London: Thomas Murby and Co., 1952.) 22*s*. 6*d*. net.

THIS account of the history of the Geological Survey of Great Britain, written by a former director of the Survey, is a noteworthy publication. Although it follows a centenary volume by one of his predecessors published still far short of twenty years ago, it will not surprise those who have known both authors that the two books differ in many respects. The present volume is one that should find a place in every geological library, and it is worthy to be added to books devoted to the history of the subject.

The Geological Survey is the oldest organization of its kind in the world, dating its institution from 1835; there was, of course, official but discontinuous geological mapping before that date in Great Britain and elsewhere. The Survey has been taken as a pattern for the organization of similar work by many countries. This book contains an account of the problems met with through this long history, and of the ways in which they have been dealt with. Each chapter (though they are not called by that name) deals with the work of one of the successive directors and with his more important achievements and difficulties. Alongside this history of Survey activities, there is some account, especially in the earlier years, of the development of geological ideas both in the Survey and outside. To the student this volume will thus supply a valuable introduction to the history of the science as a whole. As the Geological Survey grew, there was a considerable degree of similarity between the development of ideas among its members and of those who were not attached to its staff. The numbers of those geologists engaged in the Survey and in the universities have always been small—smaller than those in most sciences—and, leaving aside the very important band of amateurs whose contribution to some fields of geology have been outstanding, the Survey has held on an average about one-half of the employed geologists in Britain. It is not surprising, therefore, to find that in many ways its history is to a great extent the history of British geology.

The Geological Survey was founded in order to expedite the provision of one-inch maps with geological boundaries, and the production of such maps (each with an accompanying memoir containing a description of the geology of the area which is summarized on the map) has continued to be one of the Survey's most important tasks. Several diagrams show very clearly the progress towards this objective. But with greater demands the work became slowed down very considerably, even so long as seventy or eighty years ago. Thus the reader is shown on p. 84 how the rate of completion of English one-inch maps became less than half as rapid under Ramsay as it had been in a corresponding period under his predecessor Murchison. The rate rose again with the next director, Archibald Geikie, to exceed that reached under Murchison. This variation is partly accounted for by the use made of six-inch maps as a basis of surveying. This was officially ended by Geikie in the 'eighties, though it had been in existence for some twenty years.

Geikie was anxious to complete the geological mapping of Great Britain, having more or less undertaken on his appointment "to wind up most of the activities of his office". How many since that time have demanded to know how long it would be before the primary task of the Survey was accomplished? All one can now say, unless there is a large expansion in numbers, with the demand for greater detail and for the need for frequent revision (at least in some areas), is that the geological survey will never be complete, for new tasks are added more rapidly than they can be overtaken. Geikie would find an organization much larger than in his day, but with its responsibilities continually expanding.

So many topics are discussed in this volume, especially in those sections relating to later years, that a reviewer can only indicate the wide range of problems. The linkage with other government services is traced from the days when the Geological Survey was one of the very few scientific bodies established under the Government (many may read with amazement that in 1871 a director's funeral was joined by royal carriages and that a Prime Minister followed the bier), to its present position as one of the divisions since 1919 of the Department of Scientific and Industrial Research. The glimpse of the Geological Survey's relation to water-divining, or dowsing, in the Second World War is one of the many reminders of present activities.

Altogether this is a book from which few will not be able to learn. Other writers would perhaps have chosen differently, but with so much available, particularly of recent history, the author must make some selection. Little of importance appears to have escaped his notice, however. The book is illustrated with plates and line-drawings, many of the latter reproduced from memoirs of dates ranging from near its foundation until more than a century later and illustrating some of the more important conclusions reached in that time.

A. E. Trueman

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## ANCIENT EGYPT

### Ancient Egypt

By J. E. Manchip White. Pp. xii+217+48 plates. (London: Allan Wingate (Publishers), Ltd., 1952.) 21*s*. net.

THE history of Egypt is unlike that of any other country in the world. For centuries, indeed for millennia, geography imposed so complete an isolation on the region that the evolution of Egyptian culture, especially that of Upper Egypt, became rigidly circumscribed and unaffected by influences from the outside world. The thought of the people throughout centuries of existence seems to have been conditioned by their peculiar natural environment, canalized, almost solidified, and but little influenced by ideas germinated in other civilizations. It is true that, during periods of exceptional governmental weakness, invasions of foreigners did take place; but their effect seems not to have been permanent, and when the central authority once again became strong the invaders were turned out. Perhaps the Biblical account of the ejection of Adam and Eve from Eden is a poetical remembrance of the ejection of the Shepherd Kings from the Nile Delta.

Only when Egypt under the kings of the Eighteenth Dynasty tried to found an empire in Nearer Asia, and for a time succeeded, were the seeds of future final decadence sown. From then onwards, in spite of brilliant flashes of returning vitality, the end

became inevitable, and Alexander had few difficulties when he invaded the country—nor had his captain Ptolemy after his death. The contacts with outsiders and their ideas following on these foreign conquests of the earlier years of the New Kingdom sapped fatally the strength of the old Egyptian culture.

The volume under review is written by a poet who has studied archæology, and particularly Egyptology, thoroughly. We get, therefore, the best of both worlds—a knowledge of the available facts and a sensitive appreciation of what old Egyptian life and culture must have been like. The book is not meant for the specialist wanting every detail, but for the informed individual who wishes to realize what life and ideas were like in the remote past in this interesting land. The history of the dynasties is given very briefly in three chapters, but far more pertinent are those on the environment, the Pharaoh, the priest, the aristocrat, the architect, the craftsman and the commoner. There are a number of well-chosen illustrations and the work is an excellent introduction to the study of Egyptology.

MILES BURKITT

## "A IS HAPPY—B IS NOT"?

### British Scientists of the Twentieth Century

By J. G. Crowther. Pp. xiv+320+8 plates. (London: Routledge and Kegan Paul, Ltd., 1952.) 25*s*. net.

THE theme of this book may be taken in the author's own words: "The parallelism of trends in biology and physics is noticeable, how the Mendel–Morgan genetics and the prostitution of Rutherford's nuclear physics are seen to flourish in the same place, side by side; and, in contrast, how sounder biological theories, together with beneficent applications of atomic energy, are flourishing elsewhere in great constructive works for the dignity and happiness of man".

This *motif* is varied with studies of the lives and works of J. J. Thomson, Rutherford, Jeans, A. S. Eddington, Gowland Hopkins and William Bateson. Excellent portraits of each of these are used to illustrate the book, and a photograph of Academician T. D. Lysenko also appears. With regard to the last, in view of the title of the book, the reader may well ask "Que diable fait-il dans cette galère?", but a study of the text will soon show why.

The book gives the impression that it is the work of two authors. There is *A*, the gifted writer with a neat and clear style, and with a wide reading in the literature of science, particularly in the biographies and publications of his characters; and there is *B*, the Marxist philosopher, ever seeking an opportunity to despise British intelligence, British institutions and British theoretical physics. Most of the writing is done by *A*, but *B* always has the last word. Some examples will show how this schizophrenic method of biography works itself out.

J. J. Thomson. *A*: "J. J. was not only a teacher and discoverer, he was a creator in the method and organization of research. . . . This world-wide movement of research students to Cambridge was stimulated by the need for science teaching. . . . Unique in the galaxy of J. J.'s collaborators was C. T. R. Wilson. This most admired and Scottish of Scotsmen". *B*: "The cost to mankind as a whole of a leisured life for Newton, Clerk Maxwell and the scores of geniuses who created the subtlety and depth of the Cambridge tradition was great. . . . It is impossible to overlook the adolescent, uncultivated, unintellectual aspects of his mind and school".

Rutherford. *A*: "Rutherford departed suddenly in the midst of a healthy, happy, triumphant and glorious life". *B*: "An unconsciously tragic social figure".

Jeans. *A*: "Why was Jeans so successful as a popular writer? Because he was clear, vivid, confident". *B*: "The enormous circulation of 'The Mysterious Universe' owed much to its meretricious style and shallow philosophical thought. . . . Somehow or other, though, Jeans extracted £256,000 out of society. . . . The character of his writing for the people, revealed the intellectual bankruptcy of the British educated bourgeoisie".

Eddington. *A*: "He regarded his expositions as harmonious works of art and he made them so. It [Eddington's 'unified theory'] may prove to be the boldest, the most imaginative work of the twentieth century". *B*: "It seems probable that it will prove to be an extreme individualist aberration, a product of the weak side of Quaker solitary quietism and obstinacy, which remained uncorrected through the absence of an adequate system of mutual scientific criticism, because of a defect in social organization".

The reader can take what he pleases; but he may be left wondering how the work of Rutherford and Thomson could have been improved had they had the advantages of "an adequate system of mutual scientific criticism" in that Utopia of social organization so beloved by the author. It is, of course, possible that, instead of their superb achievements in experimental physics, they might only have succeeded in developing electric power and illumination had they been subjected to the demands of the party line; similarly, Faraday might have confined his attention to the improvement of the Leyden jar.

"See how the Fates their gifts allot,
For A is happy—B is not.
Yet B is worthy, I dare say,
Of more prosperity than A".

*The Mikado.*

W. L. SUMNER

## MANAGEMENT AND BIOLOGY OF LIVESTOCK RANGES

### Range Management

Principles and Practices. By Prof. Arthur W. Sampson. Pp. xiv+570. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 60*s*. net.

THIS book deals with a subject which, on the surface, might appear to have little interest to the British reader, but there is much in the book to interest students of many sciences as well as agriculturists to whom the book is of especial interest.

A vast subject is covered, and it is impossible to deal in minute detail with every section; but great credit must be given to the writer for the way in which he has selected his material, giving just enough of the scientific background to explain each point sufficiently for the practical man and at the same time to allow the student, who may not be so familiar with the practical aspects, to orientate himself. For the latter who wishes to pursue any section further,

there are comprehensive lists of references at the end of each chapter.

The book is divided into four main parts. Part 1, entitled "Range Management in Perspective", deals with the general concept of range management and gives a very concise picture of grazing practices throughout the world and problems which should be of interest to all concerned with the supply of meat and animal products. There follows a consideration of the scientific principles, mainly physiological and ecological, which have an important bearing on range problems, and one is struck by the similarity of many of the problems to some encountered in Britain. This leads to a consideration of some of the aspects of United States grazing, followed by a historical survey.

Part 2 is mainly botanical and deals with the many species of plants which go to make up the range, giving adequate details of the value or otherwise of each. These are classified according to natural orders, and mention must be made of the excellent line illustrations of the plants, many, but by no means all, not commonly seen in Britain. Part 3 deals with the improvement and management of range and stock, starting with the improvement of the herbage, both by natural and artificial reseeding, and the control of noxious woody vegetation. This leads, by way of management and considerations common to both range and range livestock, to livestock choice and management, followed by two chapters on general range management. Again one is struck by the broad similarity of many aspects of the subject to the management of rough grazings in Britain. The final section of the book deals with such subjects as timber and its place on the range, poisonous plants and their control, wild life on the range, soil erosion and, finally, the administration of public grazing lands.

The book will be a useful reference work for advanced students of agriculture, and certain sections will be of more than passing interest to geographers, economists and biologists.

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## PLANT CELL WALLS

### The Molecular Architecture of Plant Cell Walls

By Dr. R. D. Preston. Pp. xii+211+10 plates. (London: Chapman and Hall, Ltd., 1952.) 36*s*. net.

THE advancing study of the fine structure of plant cell-walls now has an evident relevance to problems of growth, and may also have taxonomic implications; it thus commends itself to general botanical interest. A concise account, from Dr. R. D. Preston, of the essentially botanical (as distinct from the technological) aspects of cell-wall micro-structure is thus a welcome addition to botanical literature.

To the non-specialist, however, his subject presents certain difficulties of approach, derived from its basis in unfamiliar research techniques and modes of thought. Dr. Preston therefore devotes about a third of his book to outlines of the salient features of the chemical and physical structure of cellulose and other cell-wall substances and of the techniques applicable to their study. Special attention is given to the methods of X-ray crystallography and polarization optics, which have proved most fruitful in cell-wall studies. Modern views of the micellar structure of cellulose are explained and discussed in the light of these and other techniques.

Against this physico-chemical background the main theme of the book is developed, largely by reference to the researches of the author and his colleagues. Facts and hypotheses of cell-wall structure and growth are considered in relation to the evidence, and described in terms of the mean orientation, angular dispersion and dimensions of cellulose micelles and microfibrils, and of the nature, proportion and distribution of non-crystalline material in the wall.

Thick cell-walls, having a dense, well-oriented cellulose framework, are described first, by reference to algæ, especially *Valonia*, *Cladophora* and related forms, and to cells of higher plants, especially conifer tracheids and bamboo and other fibres. Such diverse examples, while differing in detail, nevertheless exhibit a certain unity of structure; helical organization, and lamellation of the wall, in varying degrees, are common features. Primary walls are considered separately: here again different examples have a common type of structure; the cellulose framework is more diffuse than in secondary walls and less highly oriented; and protein is present among the non-cellulosic components.

From features of wall structure the author passes to processes of wall growth, of which, as yet, we know little. The growing primary wall is regarded not as a membrane separate from the protoplast, but rather as a differentiated outer layer of the latter, consisting perhaps largely of carbohydrase systems, within which cellulose deposition takes place. It is possible that deposition of the secondary wall may also occur in this way; the complexity, in *Valonia*, of growth in area of an already multi-lamellate wall, without apparent disturbance of its astonishing regularity of structure, seems especially to demand some such relationship. The concept of a definite interface between the protoplast and the wall may thus have to be abandoned. It might be added that cellulose-synthesizing systems external to the protoplast (in the ordinary usage of that term) appear in the activities of *Acetobacterium xylinum* and in the growth of the stalk of the sorocarp of *Dictyostelium*; they may well thus be of wider occurrence.

Further problems arise in the relationship between wall structure and cell shape. A detailed consideration shows that they are not simply related mechanically as has sometimes been supposed, but must be regarded as consequences of different aspects of cytoplasmic organization of which our appreciation is as yet speculative, but towards an understanding of which future cell-wall studies will extend.

In its conception, and in the broader aspects of its presentation, this is a valuable and stimulating book. The detailed exposition is, however, marred by a certain lack of coherence and an inexactness of style which make for unnecessary difficulties. This appears in the arrangement of the physical sections and in ambiguities such as the conflicting statements on pp. 48 and 71 concerning molecules and micelles; the confusion on p. 67 between $n_\gamma$ and $n_{\gamma'}$ (not apparently a mere misprint) in relation to the degree of crystallinity; and the reference on p. 140 to "cellulose micelles . . . (of) low cellulose content"—to cite but three examples among many. There are also some misprints which lead to confusion.

The book is generously illustrated, though in some instances the half-tone reproduction is inadequate. There is a bibliography of some hundred and twenty titles.

K. Wilson

# THE SECOND CŒLACANTH

By Prof. J. L. B. SMITH

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IT is my great privilege to announce the discovery of a second Cœlacanth. There are few biologists who do not remember the amazement engendered by the appearance of *Latimeria* Smith, 1939, as well as the acute disappointment in learning that all the soft parts of the fish had been lost.

For these various reasons it became a self-appointed task to endeavour to find a complete specimen, and for almost fourteen years I have constantly pursued that aim. There was overwhelming evidence that the fish was a stray, so that the first essential was to attempt to trace the habitat.

The only overseas scientist to venture an opinion on this matter was E. White, of the British Museum, whose statement that it was "almost certainly" from "the deeper parts of the sea, to which its kind have retreated in the face of fierce competition with the more active modern types of fish", scarcely took into account that numbers of successful modern fishes, some quite numerous, appear less well equipped for survival than the Cœlacanth, and a fish from the depths so well armoured would from our present knowledge indeed be a phenomenon.

From my study of fishes the Cœlacanth appeared to be a denizen of moderately deep water, living in and about rocks, presumably in an area not easily fished or commonly fished with efficiency.

My studies led me to regard the Mozambique channel about Madagascar as the most likely area, and plans for an expedition to search for more were well advanced, but fell through. I then decided on another method, and a leaflet, in English, French and Portuguese, was prepared, giving a brief account, and a photograph of the Cœlacanth, as well as offering a reward of £100 for each of the first two specimens caught.

By co-operation of the respective authorities, thousands of these leaflets were distributed throughout the coastal regions of the Western Indian Ocean, in such fashion that they reached and were explained to the native fisherfolk in even the most remote parts. During the past six years my wife and I have carried out expeditions along a considerable part of the East African coast, covering many otherwise inaccessible parts on foot. We continually spoke of the Cœlacanth and emphasized its importance, to all classes and races, and distributed leaflets. It is more than gratifying that this has led directly to the discovery, at the Island of Anjouan in the Comoro Archipelago, of the new Cœlacanth described below. The European responsible for saving the specimen was Captain E. E. Hunt, to whose trading schooner it was brought. Circumstances were such that I was compelled to fly to Pamanzi Island to retrieve the specimen, a military Dakota aircraft being provided by order of the Prime Minister, Dr. D. F. Malan. The return journey from and to Durban was completed in thirty-seven hours.

The native recipient of the £100 reward caught the fish in the evening of December 20, 1952, on a fish-baited hook, at a depth of about eight fathoms on rocky ground some 200 metres from shore off the village of Domoni, at about lat. 12° 15′ S., long. 44° 33′ E. He killed it by blows on the head. At the market next day the fish was saved from being cut up by a native who recognized it from our leaflet. It was then carried across the Island to Hunt, then at Mutsamudu village.

Having no formalin, he ordered his natives to cut it for salting, which they unfortunately did by slicing it all along the back from snout tip to tail, thereby destroying the brain and other soft parts of the head, and cutting through the gullet and axial structures. Hunt then went to Pamanzi, where he got and injected formalin. During my short time at Pamanzi he informed me that the specimen was intact, that no part had been removed. I have only in the past few days had time to examine the creature more carefully, and it is most disturbing to find that the head is shockingly battered and the body roughly and widely lacerated. On the other hand, it is apparently only the soft parts of the head, chiefly the brain, that have been lost.

This is not as disastrous as may appear, for it is more than counterbalanced by the fact that the home of at least one species of Cœlacanth has been found. The natives there know the Cœlacanth well and assert that one or two a year have been caught in that same locality regularly as far back as they know. It is likely, therefore, that over the whole archipelago more must be caught, and it should not be long before a perfect specimen can be obtained. The natives speak also of a constantly smaller Cœlacanth, which may well prove to be different, and it will in any event not be surprising if further species exist; nor is there any reason why they should not occur in other parts of the world as well. From what can be ascertained, the Cœlacanths can scarcely be regarded as degenerate fish. They are apparently full of vigour.

This fish clearly represents a new genus, and *Malania* nov. gen. is proposed, in honour of the Prime Minister of South Africa, Dr. D. F. Malan, whose prompt decision and commendable action at that late stage saved the fish. I had intended to name the species after Captain Hunt, but he preferred that it should mark the locality where the fish was caught, hence *Malania anjouanæ* gen. et sp. nov.

Owing to a printer's error, *Melania* Perry, 1811, appeared as *Malania* in Preston, *Rev. Zool. Afric.*, 1913. As there is no connexion whatever between *Melania* and *Malania*, it appears reasonable that the latter should be valid, as a generic name, for the present fish. If *Malania* is ruled as invalid, I propose the generic name *Malanius* to replace it.

## Family Latimeriidæ

The specimen of which an outline account follows resembles *Latimeria* Smith, 1939, in general facies, but is only provisionally referred to this family. A more detailed investigation may lead to other conclusions. Of interest is the presence of a well-developed spiral valve, the presence of which had been suspected in forms now regarded as extinct.

## Genus *Malania* nov.
## Genotype *anjouanae* sp. nov.

This genus superficially resembles *Latimeria* Smith, 1939, and is clearly derived from the same ancestral

Fig. 1. *Malania anjouanæ* gen. et sp. nov. Type. Male. Actual length, 1,385 mm.

type. As far as may be determined, the main surface bones of the head are very much like those of *Latimeria*; but there are differences in the smaller structures.

Immediately apparent is the absence of a supplementary caudal and of a first dorsal. The basal plate of the latter fish is present, and it is at least possible that the fin itself may have been lost by injury in early youth. That particular area of skin was mutilated in cutting; but the adjacent scaling has the appearance of having grown abnormally, as would occur in covering a scar.

The ossifications in this fish appear to be less dense than in *Latimeria*.

The whole fish is extremely oily, especially the dermal structures.

There are numerous other structural distinctions, as yet not fully worked out, which may necessitate separation by family rank for this form. These will be described later in a more detailed monograph on the specimen.

### *Malania anjouanæ* sp. nov.

The specimen has a total length of 1,385 mm. The body is robust and moderately compressed, increasingly so posteriorly.

The first dorsal is represented only by the basal plate beneath the skin. The second dorsal is relatively smaller than in *Latimeria*, while the pectoral is somewhat similar. The pelvic in *anjouanæ* is broader than in *Latimeria*, and there is a fringe of separate elongate rays along the inner hinder margin, the hindmost few again connected by membrane, forming a slight lobe that folds back over the anus and is in some respects reminiscent of the elasmobranch 'clasper'.

The anal fin is much like that of *Latimeria*.

The caudal is almost symmetrical and lacks any sign of the axial supplement. The rays are all spinose, increasingly so anteriorly.

The scales are much like those of *Latimeria*, but smaller, and the tubercles are not so marked. There are 33 series to the level of the origin of second dorsal, 56 to caudal origin and 68 to caudal base.

*The Head*

The major dermal ossifications appear to be much the same as in *Latimeria*, the opercular, the post-orbital, the squamosal, the preopercular and the lacrimo-jugal being almost identical in shape and position. There is no trace of the small ossification provisionally identified as an inter- or sub-opercular in *Latimeria*.

*Mouth Parts*

The dentigerous structures are in every way comparable with those of *Latimeria*, but the [illegible] tooth plates are smaller and less clearly distinct from one another. The teeth on the whole are smaller, and there are more granular than sharp teeth.

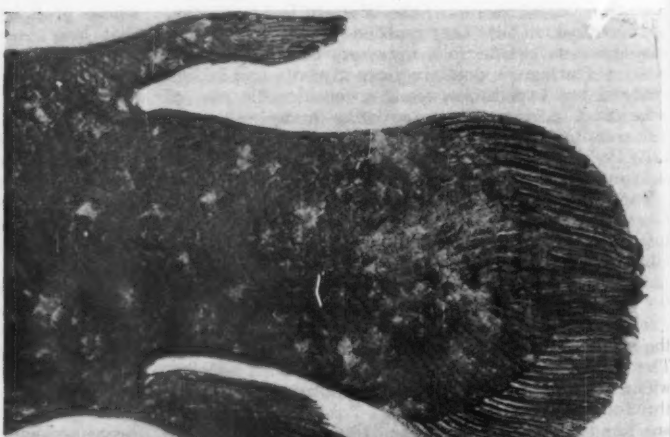

Fig. 2. *Malania anjouanæ* gen. et sp. nov. Caudal. Actual length, 550 mm.

The suspension of the lower jaw appears to diverge considerably from that of *Latimeria*, but time does not permit of more detailed investigation at present.

There is no sign of any internal narial opening.

*Copula and Gills*

The copula is much like that of *Latimeria*, and situated much as deduced for that fish[1]. There are five gill-arches, but, as deduced for *Latimeria*, only four are attached to the copula; the smaller fifth is behind. There is no slit behind the last gill. Well-marked pseudo-branchiæ are present. The gill-arches are hollow, flat, boomerang-shaped plates, the lamina formed by inverted U-shaped, thin, but strong bone, with a rod-like bony structure running inside along the dorsal margin. The outer arch is 35 mm. wide at the angle and about 8 mm. in thickness. Each side of the top of each arch bears two series of numerous fairly small plates, each beset with stout sharp spines. Mostly there is one large spine, almost a canine tooth, on each plate, together with small spines of varying size and number. The large spines on the outer face of the first gill-arch point upwards. The gill filaments are attached to the approximating but not touching lower edges of the bone, and at the angle are about 30 mm. in length, longer on the hinder limb of the arch.

*Rostral Papilla*

This is almost exactly as in *Latimeria*.

*Brain Case*

In regard to the nature and structure of the median rostral cavity and the relation of the three external "narial openings", described for *Latimeria*[1], doubts have been expressed about the accuracy of those observations by Jarvik[2]. *Malania* has exactly the same system in every respect as that described for *Latimeria*. The three external openings communicate directly with the median rostral cavity, and with nowhere else, and that cavity appears to have no direct connexion whatever with the brain.

The lateral fossæ of this median cavity, leading to the lateral openings, are completely filled with an oily jelly-like substance, and the mouth of each of the fossæ appears to have been completely closed by a stout membrane, cutting off all connexion with the outside. My observation on *Latimeria* of the possibility of water passing through the cavity is thus invalid.

Jarvik's statement[2] that I maintained this system as having something to do with the olfactory system of Cyclostomes is not correct.

The actual brain cavity is almost exactly as for *Latimeria*, and so far as may be observed at present, the 'olfactory' lobes of the brain do not communicate directly with any aperture on the snout.

*Axial Skeleton*

The notochord is massive and entirely cartilaginous, the walls being quite soft and about 8 mm. thick. The tube is about 40 mm. internal diameter at its widest part, tapering posteriorly. It had been hacked through roughly by Hunt's natives, so the contents are lost. The anterior end curves up, then down, to end in an imperforate fossa in the posterior ossified cranial wall.

On the anterior and on the posterior parts of the sheath are neural and hæmal processes, the shape of which there has been no time to determine, but they seem to be cartilaginous. They appear to be few or absent along most of the central part of the sheath.

*Abdominal Viscera*

Brief examination shows that the intestinal canal is comparatively short. The gullet merges into a long stomach the posterior end of which is well behind the anus. Near the anterior end of the stomach is a wide pyloric aperture, leading to a comparatively short and slender 'duodenum' about 7 in. in length, which runs anteriorly from the pylorus. At its anterior end there is a sharp reverse flexure, which is the anterior part of a 9-in. long, fairly slender, more or less fusiform spiral valve, of apparently complex structure, with six or seven revolutions in its length. The gut issuing from the valve is about 9 in. in length, slender and simple, running direct to the anus. Attached to almost the whole length of the spiral valve is an elongate sub-nodular organ, a pancreas, or its antecedent, apparently discharging into the anterior end of the spiral valve.

The fish is a male, the paired testes being about 7 in. in length, long, slender subfusiform, and partly segmented and entirely posterior to the anus. I can discern no clear indication of any structure which may be regarded as an intromittent organ, but on the external parts of the genital opening there appear to be two large flat fleshy papillæ. The urogenital opening is large and lies immediately behind and between the pelvic bases.

In the intestine were found the two eyeballs of a fish and some scales. The former indicate a fish prey of possibly 2 ft. in length.

The liver is of curious appearance, almost black, elongate, sub-cylindrical, the left lobe reaching two-thirds of the length of the cavity, the right shorter, about three-fifths of the left. This has not yet been investigated.

I wish to pay tribute to our Prime Minister, Dr. D. F. Malan, for his prompt response to my appeal for assistance to fetch this fish from the Comoro Islands. Also to M. Pierre Pierre Coudert, Governor of the Comoro Archipelago, for his cordial co-operation. Captain E. E. Hunt deserves every credit, first for having taken the trouble to learn as much as possible about Cœlacanths, and also for having saved what he did under great difficulties.

[1] Smith, *Trans. Roy. Soc. S. Africa*, **28**, 54 (1939).
[2] *Zool. Bidrag. Fran. Upsala*, **21**, 591 (1942).

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# A. A. MICHELSON, 1852–1931

By Prof. R. S. SHANKLAND
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THE Cleveland Physics Society met on December 19, 1952, to commemorate the centenary of the birth of Albert A. Michelson and to dedicate a plaque in memory of the Michelson–Morley experiment. The plaque was presented by the Case Institute of Technology and the Western Reserve University, and is to be erected in Cleveland, Ohio, on the line between their adjacent campuses near the spot where the Michelson–Morley experiment was performed.

Michelson was born on December 19, 1852, in Strelno, Germany, now Strezelno, Poland. When he

was two years old the family moved to California, where Michelson finished his high-school education in San Francisco, and in 1869 he entered the United States Naval Academy at Annapolis on a special appointment from President Grant. He graduated in the class of 1873 and, following the usual cruises as a past midshipman, served during 1875–79 as instructor in physics and chemistry at the Naval Academy.

While at Annapolis in 1877, Michelson made his first measurement of the speed of light, employing an important improvement which he had made on Foucault's rotating-mirror method. This work led to his association, in 1880, with Simon Newcomb at the Nautical Almanac Office, Washington, D.C., where they collaborated in further measurements of the speed of light. In September 1880 Michelson went to Europe and for two years studied and carried out research at Paris, Heidelberg, Berlin and Potsdam, and it was while at the Collège de France in 1880 that he invented the Michelson interferometer as a means for measuring the earth's motion through the æther. His interest in this problem had been aroused by a letter from James Clerk Maxwell to D. P. Todd, who was director of the Nautical Almanac Office during Michelson's appointment there. Maxwell had emphasized that all experiments attempting to observe the earth's motion through the æther, which depended on measuring the first power of the ratio of the earth's speed to that of light, were doomed to failure. He went on to say that no terrestrial experiment for measuring the velocity of light could detect the earth's motion in space, since "in the terrestrial methods of determining the velocity of light, the light comes back along the same path again, so that the velocity of the earth with respect to the ether would alter the time of the double passage by a quantity depending on the square of the ratio of the earth's velocity to that of light, and this is quite too small to be observed"[1]. Michelson's interferometer and the 'Michelson experiment' which he devised were the direct results of this challenge by Maxwell. The first trial of the experiment was made in Helmholtz's laboratory in the University of Berlin; but street traffic made observations impossible. The interferometer was therefore removed to Potsdam where, in April 1881, a second trial was made at the Astrophysical Observatory. The experiment gave a null result[2]; but, as the expected effect due to the motion of the earth in its orbit was only a shift of 0·04 of a fringe when the interferometer was rotated through 90° in the horizontal plane, this result was never considered conclusive, especially by Michelson himself[3].

In September 1882 Michelson went to Cleveland and began his duties as professor of physics in the Case School of Applied Science (now Case Institute of Technology). He had been appointed on March 28, 1881, but had been granted leave to remain in Europe until his researches there were completed. During his first two years in Cleveland, Michelson made further measurements on the speed of light, obtaining 299,853 ± 60 km./sec. for the value reduced to a vacuum, which was the most reliable measure until 1927. He also discovered the difference between phase and group velocities of light in carbon disulphide, this being the first experimental confirmation of Lord Rayleigh's dispersion theory for this effect[4].

Interest in the æther problem was revived when Michelson and Edward W. Morley, professor of chemistry and natural history in the Western Reserve University, Cleveland, attended the series of lectures by Lord Kelvin (then Sir William Thomson) on "Molecular Dynamics and the Wave Theory of Light" given at the Johns Hopkins University, Baltimore, during October 1884. Lord Rayleigh was also present for part of these lectures, and both he and Kelvin urged that a new trial of the Potsdam experiment be undertaken. Thus began the collaboration of Michelson and Morley. Their first work together, however, was not to repeat the Potsdam experiment, but to carry out in greatly improved fashion Fizeau's experiment on the speed of light in moving water[5]. At that time Fizeau's result was considered to be in conflict with Michelson's Potsdam experiment, and there seems to have been considerable doubt as to its validity. As all theoretical treatments of the æther problem involved Fizeau's 1851 measurement of the Fresnel dragging coefficient, it was felt that a new experiment should be performed to subject this question to a decisive test. By employing a modified form of the Michelson interferometer, greatly improved optics, compared to those available to Fizeau, were brought into play, and with other refinements for controlling and measuring the water flow they obtained a result[6] in very close agreement with the Fresnel theory and also with the more precise and satisfying formulation given by the Lorentz "Theory of Electrons"[7].

After completing this work in 1886, Michelson and Morley undertook the investigation which has since been known as the Michelson–Morley experiment, employing for this a greatly improved Michelson interferometer compared to that used at Potsdam. The optical paths were lengthened by multiple reflexion of the light beams so that the expected effect due to the earth's orbital motion was increased from 0·04 to 0·4 of a fringe. For greater stability, freedom from vibration and ease of rotation, the optical system was mounted on a sandstone slab 150 cm. square and 30 cm. thick, which was supported on an annular float in an annular trough full of mercury. The work with this apparatus continued from 1886 until July 1887 and was conducted in buildings on the adjacent Case and Western Reserve campuses. The definitive null result obtained in these experiments[8] led to profound changes in the development of physics. The contraction hypothesis of G. F. FitzGerald was the first serious attempt to explain the result of Michelson and Morley, and this contraction, together with the concept of 'local time', was elaborated in Lorentz's revised "Theory of Electrons" to provide an adequate but rather artificial interpretation for the Michelson–Morley experiment[7]. It is needless to say that the most direct and now universally accepted explanation for the Michelson–Morley experiment, as well as for the Fizeau experiment and the phenomena of astronomical aberration, is provided by the special theory of relativity given by Albert Einstein in 1905 [9].

The collaboration of Michelson and Morley continued during 1887–89 when they established the feasibility of making the light wave the ultimate standard of length, a programme which was carried to completion by Michelson in Paris in 1892. In the course of this investigation, they discovered the fine structure of the red hydrogen and other Balmer lines and the hyperfine structure in the spectrum of mercury[10]. Later, Morley conducted his notable determinations of the atomic weights of oxygen and hydrogen, and Michelson, first at Clark University and then for many years at the University of Chicago

and at the Lick and Mount Wilson Observatories, carried on his many famous investigations in spectra and optical metrology.


[1] Maxwell, J. C., *Nature*, **21**, 314 (1880).
[2] Michelson, A. A., *Amer. J. Sci.*, **22**, 120 (1881); *Phil. Mag.*, **13**, 236 (1882).
[3] Michelson's letter to Lord Rayleigh from Cleveland, March 6, 1887.
[4] Lord Rayleigh, *Proc. London Math. Soc.*, **9**, 21 (1877).
[5] Fizeau, H. L., *C.R. Acad. Sci., Paris*, **33**, 349 (1851); *Ann. Phys. Chim.*, **57**, 385 (1859).
[6] Michelson, A. A., and Morley, E. W., *Amer. J. Sci.*, **31**, 377 (1886).
[7] Lorentz, H. A., "Theory of Electrons".
[8] Michelson, A. A., and Morley, E. W., *Amer. J. Sci.*, **34**, 333 (1887); *Phil. Mag.*, **24**, 449 (1887).
[9] Einstein, A., *Ann. d. Phys.*, **17**, 891 (1905).
[10] Michelson, A. A., and Morley, E. W., *Amer. J. Sci.*, **38**, 181 (1889).


# INTERACTION OF CHLORINE DIOXIDE WITH FLOUR: CERTAIN CHEMICAL ASPECTS


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FOLLOWING the discovery that agene-treated flour could produce hysteria in dogs and certain other animals, the whole question of flour improvers is being very carefully considered in many countries. It is clearly essential that an improver should not only meet the technical requirements necessary for present-day methods and standards of bread-making, but should also be completely acceptable from the point of view of public health. In the United States, chlorine dioxide has replaced agene as the more commonly used improver. This decision was taken after extensive feeding experiments with dogs, rabbits, rats, monkeys and human beings[1,2] had shown no clinical evidence of acute toxic symptoms or abnormalities in any of the species tested.

The feeding trials carried out in the United States are reassuring; such investigations are an essential first step in deciding whether or not the interaction of flour with chlorine dioxide could lead to the formation of deleterious substances. In a problem of this character, however, there are certain limitations in such animal-feeding tests. The gaseous flour improvers are applied at very low concentrations; chlorine dioxide at about 30 parts per million. They may interact with a number of the constituents of flour and not exclusively with one. There is the possibility, therefore, that flour treated with an improver may contain traces of a number of unknown substances, without necessarily reducing significantly the amount of any one essential metabolite. In these circumstances the overall composition of the experimental diet used in the tests may be decisively important. A certain diet may, for example, accentuate the effect of a deleterious factor or it may neutralize it. Thus, in our work with methionine sulphoximine, the agene toxic factor, we encountered an example[3] of a change in the dietary of rabbits neutralizing the toxic effect of sulphoximine. Again, since the chemical nature of any new substance is unknown, it is not possible to plan dietaries with which neutralizing or masking effects will be minimized.

In our opinion, it is important, in studies on the effect of chemical treatment of food, to supplement the essential biological tests with biochemical investigations. If it is possible to identify modified substances, then these may be studied in animal-feeding trials and their effect observed on isolated enzyme systems. Because of the importance of flour as a staple article of diet, we consider both types of investigation—tests with animals and chemical studies—to be essential. In addition to animal-feeding tests, which are continuing, we have investigated some of the interactions which occur between chlorine dioxide and flour and fractions derived from flour. This article summarizes the observations we have so far made. It is hoped to publish elsewhere a more detailed account of the methods and techniques used. Both pure chlorine dioxide and chlorine dioxide containing approximately 30 per cent chlorine have been used.

## Interaction with the Lipoids of Flour

The lipoids of flour interact readily with chlorine dioxide and with chlorine. With pure chlorine dioxide, the unsaturated fatty acids are the initial sites of an oxidative process which appears to include some degree of polymerization. The iodine number of fat extracted from 81 per cent extraction flour is about 112, whereas that of fat extracted from similar flour treated with chlorine dioxide, at ten times the commercial level, is about 103. If a solution of this 'treated' fat in petroleum ether is kept at room temperature, there is a slow deposition of an insoluble rubber-like polymer. The initial oxidation reaction with unsaturated fatty acids is observed both at commercial levels of treatment and at higher levels. This has been demonstrated by an adaptation of the method of Wilbur, Bernheim and Shapiro[4], who have shown that thiobarbituric acid is a sensitive reagent for detecting autoxidation and catalysed oxidation of unsaturated fatty acids in biological material. The products of oxidation when treated with the thiobarbituric reagent give a pink colour with a characteristic absorption spectrum. Table 1 records observations made with flour treated with a number of improvers, and with untreated flour.

From these results it will be noted that untreated flour three months old may have an oxidation value, as shown by the thiobarbituric test, either less or greater than that of flour treated with chlorine dioxide at the commercial level. Different flours apparently vary in this respect, presumably because

Table 1

| | Material tested: 81 per cent extraction flour | Colour with thiobarbituric reagent |
|---|---|---|
| (I) All the same Manitoba flour | (1) Treated with chlorine dioxide at 10 times commercial level | Strong orange pink |
| | (2) Treated with agene at 10 times commercial level | Strong orange pink |
| | (3) Treated with bromate at 10 times commercial level | Very faint pink |
| | (4) Treated with persulphate at 10 times commercial level | Slight pink (> No. 3) |
| | (5) Treated with chlorine dioxide at the commercial level | Pink (< No. 1 but > No. 4) |
| | (6) Untreated flour 3 months old | Similar to No. 3: very faint pink |
| (II) Mixed grist flour | (7) Treated with chlorine dioxide and chlorine at the commercial level | Very faint pink (< No. 9) |
| | (8) Treated with chlorine dioxide and chlorine at 10 times commercial level | Strong orange pink |
| Manitoba flour as in (I) | (9) Untreated flour 3 months old | Very faint pink |
| | (10) Untreated flour 12 months. | Pink (> No. 9) |

of varying content of natural anti-oxidant substances. An untreated flour, twelve months old, has a considerably higher value than flour treated with chlorine dioxide at the commercial level. Whether the polymerization effect, noted with fat extracted from flour treated at ten times the commercial level, is also observed with an aged flour, for example, nine to twelve months old, has not yet been investigated.

There is no significant chlorination of the fat when pure chlorine dioxide is applied to flour, and most of the chlorine originally bound in the chlorine dioxide molecule appears ultimately in the form of water-soluble chloride. If the gas applied contains free chlorine, there is chlorination of the fat. As much as 40 per cent of the chlorine applied may be found in the fat extractable from the flour with petroleum ether.

The oxidation (or peroxidation) of lipoids by chlorine dioxide or air may be an important primary step in a sequence of oxidative changes affecting other flour constituents. In this connexion, if the fat from flour treated with chlorine dioxide at ten times the commercial level is deposited on kieselguhr together with methionine and the mixture kept in the dark, the methionine is oxidized almost completely to methionine sulphoxide with a little of the sulphone. With fat from untreated flour under similar conditions there is no significant oxidation of the methionine within the same period of time. This observation, of a non-enzymatic transfer of oxygen, may be of interest in other fields of work connected with food and nutrition. In relation to the present problem it has led us to pay particular attention, in the work on protein fractions, to the lipo-protein complexes which may be obtained from petroleum ether extracts of flour.

## Reaction with Tocopherols

Flour containing wheat germ, for example, flour of 81 per cent extraction, is a useful source of vitamin E. In view of the oxidative effect of chlorine dioxide on fat, and the sensitivity of this fat-soluble vitamin to oxidation, some observations have been made on the stability of tocopherols in flour to treatment with chlorine dioxide. These have been made on the flour stream rich in germ from a commercial mill before and after chlorine dioxide treatment under commercial conditions. A chemical estimation of total tocopherols has been used, based essentially on Parker and McFarlane's[5] adaptation of the Emmerie–Engell method but modified by using the last stage of the Wall and Kelley[6] procedure. The tocopherol content of the treated flour was reduced by about 70 per cent compared with the untreated flour. The nature of the oxidation products has not been investigated, and we have not yet carried out tests with animals to examine whether or not they have retained any biological activity similar to that of vitamin E.

## Interactions with Proteins

Many of the amino-acids readily react with oxidizing agents and halogens. When they are linked together by peptide bonds, as in proteins, their reactivity may differ, compared with when they are free, and the type of reaction may be different. Only those residues at the end of peptide chains will have free α-amino or carboxyl groups. Reaction with the side-chains may also be influenced by the presence and nature of the neighbouring groups, by the spatial configuration of the various residues in the peptide chains, and by interchain bonding. In this connexion it is interesting to recall that the agene toxic factor, methionine sulphoximine, is not formed when free methionine reacts with nitrogen trichloride but only when methionine is a component residue in a protein. It also follows that similar residues or groups within a given protein may differ in their reactivity and also, of course, in their reactivity in one protein compared with another. It is therefore useful to examine hydrolysates from different types of proteins which have interacted with chlorine dioxide.

For the immediate purpose it would suffice to consider the total protein of flour, as this would include a variety of types of protein. But this would involve hydrolysis of whole flour, and the presence of so much carbohydrate leads to losses of an unknown order and favours the production of artefacts. Another approach would be simply to compare the gluten from treated and untreated flour. It is not, however, possible to wash out a gluten, from flour treated with chlorine dioxide at ten times the commercial level, which is comparable with that from untreated flour. For these reasons we have, in addition to comparing fractions from treated flour with similar fractions from untreated flour, also isolated fractions and then treated them directly with chlorine dioxide. There are a number of limitations to be noted. First, we have worked with totally hydrolysed protein fractions. Therefore we should not detect any modified amino-acids which are unstable to conditions of total acid hydrolysis. Secondly, our final observations have been made with paper chromatograms using ninhydrin. We should not, therefore, detect any substances present which do not give a colour on the paper chromatogram with this reagent.

Hydrolysates have been fractionated by ionophoresis in a four-compartment cell of the type described by Synge[7], displacement chromatography on ion-exchange resins and, occasionally, on kieselguhr partition chromatograms. Fractions at different stages have been examined on two-way paper chromatograms. In all cases the appropriate untreated fraction has been examined by the same procedure as the treated fraction. Table 2 records amino-acids observed in treated material but not in untreated material. Methionine sulphoxide is only noted if present in significantly greater amount than in the control.

In some of the examples given in Table 2 we have calculated the amounts of modified amino-acids formed (see Table 3). This has been done by comparisons, on paper chromatograms, with known amounts of the appropriate substances. The calculations are admittedly rough but they give an idea of the order.

The levels of treatment with chlorine dioxide which have been employed in this work are considerably higher—in some cases fantastically higher—than those normally used in the commercial mill. This, however, is a reasonable first approach in investigations which have a toxicological aspect, and it was used successfully in our work on the isolation of the agene toxic factor[8]. Furthermore, the present study has been chiefly concerned with noting the types of reaction which are most likely to occur and which are most readily detected. It has also been our experience that the same reactions occur at different levels of treatment, though of course they are progressively less as the level of treatment is reduced. At commercial levels of treatment the production of modified amino-acids, for example, will

Table 2

| Protein fraction | Treatment | Modified amino-acids found |
|---|---|---|
| (1) *Gliadin* prepared from untreated flour (75% extraction) | Gliadin preparation saturated with $ClO_2/Cl_2$ absorbed 2,400 mgm./100 gm. | Monochlortyrosine, dichlortyrosine, methionine sulphone, methionine sulphoxide |
| (2) *Gliadin* extracted from treated flour (75% extraction) | Flour treated with $ClO_2/Cl_2$ at 7·9 mgm./100 gm. | Methionine sulphoxide |
| (3) *Gliadin* extracted from treated flour (81% extraction) | Flour treated with pure $ClO_2$ at 29·6 mgm./100 gm. | Methionine sulphoxide |
| (4) *Gliadin* prepared from untreated flour (81% extraction) | Gliadin preparation treated with $ClO_2$ containing 0·08% $Cl_2$ at 550 mgm./100 gm. | Methionine sulphone, monochlortyrosine |
| (5) *Zein* (Corn Products Co.) | Saturated with $ClO_2/Cl_2$ absorbed 2,400 mgm./100 gm. | Methionine sulphoxide, methionine sulphone, monochlortyrosine |
| (6) *Lipoprotein complex* extracted from treated flour (81% extraction) | Flour treated with pure $ClO_2$ at 79 mgm./100 gm. | Methionine sulphone |
| (7) *Lipoprotein complex* extracted from treated flour (81% extraction) | Flour treated with pure $ClO_2$ at 29·6 mgm./100 gm. | Methionine sulphone |
| (8) *Lipoprotein complex* extracted from untreated flour | Lipoprotein preparation treated with $ClO_2$ containing 1% $Cl_2$ at 2,730 mgm./100 gm. | Methionine sulphone, monochlortyrosine |
| (9) *Lipoprotein complex* extracted from untreated flour (81% extraction) | Lipoprotein preparation treated with pure $ClO_2$ at 2,900 mgm./100 gm. | Methionine sulphone, cysteic acid, one unidentified substance |
| (10) *Lipoprotein complex* extracted from treated wheat germ | Wheat germ saturated with $ClO_2/Cl_2$ | Methionine sulphone, cysteic acid, monochlortyrosine, dichlortyrosine, one unidentified substance. Ethanolanine reduced by about 50% |
| (11) *Lipoprotein complex* extracted from treated flour (81% extraction) | Flour treated with $ClO_2/Cl_2$ at 40 mgm./100 gm. | Methionine sulphone, monochlortyrosine |
| (12) *Lipoprotein complex* extracted from germ-rich stream from commercial mill | Flour stream had been treated with $ClO_2/Cl_2$ at usual commercial level for this stream | Monochlortyrosine, methionine sulphone, cysteic acid |
| (13) *Albumin-type protein* extracted from treated wheat germ | Wheat germ saturated with $ClO_2/Cl_2$ | Methionine sulphone, cysteic acid, monochlortyrosine, dichlortyrosine |

The normal commercial treatment of flour averages 3 mgm./100 gm. flour

be of an extremely low order, and therefore difficult if not impossible to detect with the experimental techniques at our disposal.

The amino-acid residues which are attacked, in a variety of protein fractions, and which give ninhydrin-positive modifications which are stable to total acid hydrolysis, are methionine, cysteine and tyrosine. These may, in fact, be the most susceptible in the intact protein; but this cannot be considered as completely established by the present work, as other amino-acid residues may be equally susceptible to attack, though, as already stated, the products may be either unstable to acid hydrolysis or may fail to give a colour with the ninhydrin reagent. If pure chlorine dioxide is used, oxidation reactions predominate, with the formation of cysteic acid and the oxides of methionine. If free chlorine is also present, then halogenation occurs, and in these circumstances we have usually noted the presence of monochlortyrosine and, at higher levels, dichlortyrosine. In none of the protein fractions treated with chlorine dioxide, or derived from treated flour, have we observed the presence of the agene toxic factor—methionine sulphoximine.

It would obviously be easier to comment on the practical significance of this work when more results have been accumulated by other workers and by ourselves. As, however, the question is regarded as of urgent national importance, we have considered that we should record the results we have so far obtained. If, however, they are presented without some expression of our opinion of their significance, they may be given interpretations to which we should not necessarily subscribe. This possibility arises because the whole question of chemical additions to food is controversial and widely debated. For these reasons a brief comment appears desirable.

Table 3

| Fraction as described in Table 2 above | Modified amino-acid found | Estimated amount of modified amino-acid present | |
|---|---|---|---|
| | | per cent of protein fraction | p.p.m. in flour |
| 6 | Methionine sulphone | 0·1 | 0·12 |
| 8 | Monochlor-tyrosine | 0·1 | |
| 9 | Methionine sulphone | 2·0 | |
| | Cysteic acid | 1·0 | |
| 12 | Monochlor-tyrosine | 0·01 | 0·001 |

At commercial levels of treatment with chlorine dioxide, the production of the modified amino-acids which we have observed is quantitatively so small that the reduction in the content of the parent amino-acids is certainly negligible. Again, because of the very low concentration of these modified amino-acids, it also follows that they are unlikely to induce toxic symptoms unless they are extremely potent anti-metabolites such as methionine sulphoximine. So far as we have been able to ascertain from our own limited feeding trials, they have no such acute toxic properties. Methionine sulphoxide is the most readily produced modification of those we have observed, and we have noted that this substance is present, at concentrations approaching those to be expected with commercial chlorine dioxide treatment, in *untreated* samples open to ordinary atmospheric oxidation. The chlortyrosines have not been observed when chlorine dioxide free from chlorine was used.

Judged by the thiobarbituric acid test, the degree of oxidation of unsaturated fatty acids by chlorine dioxide, applied at commercial levels, may be no greater than is observed with some flours (untreated) which are three months old, and considerably less than with untreated flour twelve months old. We do not yet know whether the fat extracted from such aged flour undergoes polymerization similar to that observed with fat from flour treated with chlorine dioxide at ten times the commercial level.

The reduction in tocopherol content should be assessed, by the appropriate authorities, in relation

to the overall supply of vitamin E in the dietary. We consider that this aspect of the work requires further investigation, using biological tests, primarily to ascertain whether or not the oxidation products may have an anti-vitamin E activity.

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## FORTIETH ANNIVERSARY OF THE DISCOVERY OF X-RAY DIFFRACTION

WHEN Max Laue, then a young *Privatdozent* at the University of Munich, saw, early in 1912, the successful result of the attempt made at his request by Friedrich and Knipping to diffract X-rays by a crystal grating, he could scarcely have imagined the effect that this success would have on so many and so varied branches of science, followed as it was to be by the opening up of X-ray spectroscopy and crystal structure analysis by W. H. and W. L. Bragg. A tribute to this fundamental work of Laue was given by the X-ray Analysis Group of the Institute of Physics, at the instance of the British National Committee for Crystallography, by the arrangement of a special meeting held in London at the Royal Institution during October 24–25*, with an anniversary dinner in London. Many famous figures were able to attend this meeting, and many of them spoke, either during the meeting or at the dinner, including Prof. von Laue himself, Sir Lawrence Bragg, Sir Charles Darwin, Prof. J. D. Bernal, Prof. J. M. Bijvoet, Dr. C. Sykes, Dr. Dorothy Hodgkin and Prof. G. V. Raynor. To complete the picture, a congratulatory message from the American Crystallographic Association, sent by Prof. P. P. Ewald, himself one of those associated with the early work of Laue, was read out by the chairman of the Group, Dr. W. H. Taylor, before the meeting began.

The first session began with an account, given by Sir Lawrence Bragg, of the early days of X-ray diffraction. He told of how Laue's interest in the X-ray problem was aroused by a problem of Ewald's on the double refraction of light, and how Friedrich, somewhat against Sommerfeld's wishes (who thought that he should be getting on with other work), was persuaded, with the help of Knipping, to try the now famous experiment with a copper sulphate crystal. The various stages of the work were described in some detail, and Sir Lawrence mentioned that the early papers had recently been reprinted in *Die Naturwissenschaften* (16, 361; 1952). Sir Lawrence went on to describe the early work of his father and himself and to tell how he first hit upon the now famous idea of the 'reflexion' of a continuous spectrum (rather than one composed of discrete wave-lengths as Laue had supposed) by atomic planes, and the part played by the conception of a crystal lattice, which was then new to him. He outlined some of his early results on crystal structures and traced the development of X-ray spectroscopy by his father, following this by a mention of the early theoretical work of Darwin on the scattering of X-rays by perfect and imperfect crystals, which was so much in advance of experiment that it was overlooked and afterwards worked out in another form by Ewald. He ended by pointing out how many of the later developments had, in fact, been foreshadowed in the first three years.

Sir Lawrence was followed by Prof. von Laue, who spoke about his own experiences in those early days; this was not on the programme, and the pleased surprise of the audience was obvious. Speaking in German, apart from a few introductory remarks in English, he told of the first experiments in Munich and of his own contributions to the work, confessing that, like W. L. Bragg, he too was unfamiliar at the time with the conception of a crystal lattice. He characterized the German contribution as one concerned with 'principles' and the British as one concerned with 'models'. The former approach had been in danger of causing the subject of X-ray diffraction to run into a dead end, from which it had been saved by the latter; and Prof. von Laue pleaded for a collaboration between the two nations in political matters which should be as effective in the cause of peace as it had been in the cause of science. A summary of his remarks was then given in English by Dr. W. F. Berg.

After Sir Lawrence Bragg's historical review, and following Prof. von Laue's remarks, Prof. J. D. Bernal gave a talk in which, after some reminiscences of his own concerning his early days at the Royal Institution with Sir William Bragg, he discussed the future of X-ray crystal analysis in the light of recent developments. He showed how the real crystal, rather than the ideal, is becoming more and more the main object of study and forecast that we should, as a consequence, be led to a greater understanding of such phenomena as epitaxy, adsorption and catalysis, followed ultimately by an explanation of the phenomena of plastic deformation, creep, hardening and fatigue. Turning to methods of structure analysis, he hoped that the time would come when information justifiable on chemical grounds—the known mutual arrangement of constituent atoms in the structure, known ionic or atomic dimension, etc. —could be added to the X-ray data in a rigorous way. Prof. Bernal foresaw that, with the help of electronic and other computing machines, the heaviest part of crystal structure analysis would ultimately be automatic; he even foresaw that the reduction of observations might become so, the output being linked directly to the computer. But, as he said, we are still a long way from being able to drop a crystal down a hopper and receive a table of atomic co-ordinates or an electron density map within a short time.

The second session, on the morning of October 25, was devoted to 'review' papers on various present-day applications of X-rays, Dr. Dorothy Hodgkin dealing with chemical problems, Prof. G. V. Raynor with problems of the metallic state and Sir Lawrence Bragg with the application of X-rays to protein structure.

Dr. Hodgkin dealt mainly with recent developments in the analysis of organic structures and

* See "Forty Years of X-ray Diffraction", by Prof. J. M. Bijvoet, Prof. J. D. Bernal, Prof. A. L. Patterson and Sir Lawrence Bragg (*Nature*, **169**, 949; 1952).

described, among other things, the way in which it is now possible, in certain instances, to determine the positions of hydrogen atoms. She then traced the way in which our knowledge of stereochemistry has been increased by our ability to study the effects of such factors as the repulsive forces between non-bonded atoms in addition to those of the classically directed valencies. Finally, she referred to the analysis of such complex compounds as vitamin $B_{12}$ and the problems set for the theoretical chemist by the molecular configurations recently found in substances such as the boron hydrides.

Prof. Raynor, after surveying the part played by the electron theory of metals in the development of our ideas of the metallic state, discussed Pauling's suggested valencies and described how, by making absolute measurements of X-ray scattering power, a check might be obtained on these. He added that such an attempt, recently made in Chicago, favoured, if anything, the conventional valencies. Other points dealt with by Prof. Raynor concerned the examination of the diffuse X-ray background, on one hand to determine the local distortions around dissolved atoms in alloys and, on the other, to measure the elastic constants of metals.

In the final talk of the conference, Sir Lawrence Bragg dealt with his recent work at Cambridge on hæmoglobins, carried out in collaboration with Dr. M. F. Perutz. He said that a systematic attempt is being made, based on an extensive series of intensity measurements of the diffraction by a hæmoglobin crystal at various stages of shrinkage, to see just how much could be discovered without making any structural assumptions; and he described a series of ingenious steps by which not only the size and shape of the protein molecule has been established, but from which also the distribution of scattering matter within the molecule is beginning to be understood. When it is realized that the volume of the molecule is 83,000 A.$^3$ dry and 116,000 A.$^3$ hydrated, the magnitude of this task will be appreciated; but Sir Lawrence gave every hope that, as he put it, we are now in sight of the promised land.

Space does not permit a detailed discussion of these or the previous papers, but a fuller report of the conference will appear in the *British Journal of Applied Physics*.

An account of the conference would be incomplete without a further reference to the dinner held on the evening of October 24, at which Prof. von Laue, replying to the toast of "X-ray Diffraction and the International Union of Crystallography", proposed by Sir Charles Darwin, made what is believed to be his first public speech in English. He began by referring to his early days in Strassburg and ended by hoping, as Röntgen had done before him, that, even if those younger workers present were not as lucky as he had been, they would derive as much enjoyment from their work as he had done from his. In a final gesture, he drank their health in a personal toast which was all the more appreciated for being so entirely and so obviously spontaneous.

In conclusion, a few words must be said about the historical exhibits at the Royal Institution which were shown during both days of the conference. Among other things on view were the original Bragg spectrometer, reproductions of Laue's original photographs, correspondence and note-books of the two Braggs, letters written by Barlow, Moseley and others, and even a (correct) model of rock salt constructed from balls of wool and knitting needles by Prof. Crum-Brown in Edinburgh in 1883. No one who attended the conference could fail to be impressed by the tremendous vitality of X-ray crystallography as well as by its versatility and power in application. He would indeed be a bold man who would guarantee what the next forty years of X-ray diffraction will bring forth.

J. THEWLIS

# OBITUARIES

## Dr. C. H. Kellaway, F.R.S.

CHARLES HALLILEY KELLAWAY, director-in-chief of the Wellcome Research Institution, London, died on December 13 at the age of sixty-three. He was born in Victoria, and was educated at Melbourne Church of England Grammar School. A brilliant student, always the head of his year, he graduated at Melbourne in 1911, and after holding house appointments at Melbourne Hospital, became resident medical tutor at Trinity College, Melbourne, and then acting professor of anatomy at the University of Adelaide. During the First World War he served as a regimental medical officer with the 13th Australian Infantry Battalion in the Middle East and won the M.C. At the end of the War he worked at the Lister Institute in London under Dr. H. H. (now Sir Henry) Dale for a short period, and then became acting professor of physiology at Adelaide for a short time. In 1920 he was in England again as a Foulerton Scholar of the Royal Society. He worked at the National Institute for Medical Research and at University College Hospital, London. He returned to Australia as director of the Walter and Eliza Hall Institute, Melbourne, in 1923. During the Second World War he was director of pathology for the Australian Medical Services and later scientific liaison officer with D.G.A.M.S. In 1944 he retired with the rank of brigadier and became director-in-chief of research to the Wellcome Foundation, Ltd.

Kellaway's main interest in scientific work was initiated by his collaboration with Dale on the mechanism of anaphylaxis, and through most of his work he returned to the problem of cell damage and the associated release of histamine and similar substances. He was a pharmacologist working in the field of experimental pathology. The Hall Institute was closely connected with the Melbourne Hospital, to which Kellaway was appointed specialist physician, and consequently most of his research there was related with practical medicine. He worked on hydatid antigens and intradermal tests in the diagnosis of hydatid disease, on renal infection and hypertrophy. He studied intensively the pharmacology of the venom of the numerous Australian colubrid snakes, including many not previously studied, and extended his researches to the venom of spiders, the bee and the duck-billed platypus. He produced antivenoms in horses to several of the larger Australian snakes and collected venom from the snakes himself. In the course of this work he was once bitten by a tiger snake. His life was probably saved by the injection of antivenom; but he nearly died from serum reaction. He was one of the world's leading authorities on snake venoms. He continued his work on anaphylaxis and the histamine problem; one of his last personal investigations was conducted with collaborators on the pharmacological action of the toxins of the *Clostridium welchii* group,

particularly in reference to the action on the pulmonary circulation. This was a good example of the application of physiological methods to experimental pathology; evidence was obtained that histamine, or a substance pharmacologically similar, was a link in the chain of action of the toxin.

Concurrently with all his personal research, Kellaway steadily developed the work of the staff of the Hall Institute. He had a gift for choosing able workers, and for fostering them. In the 'thirties, virus work was started under the present director, Sir Macfarlane Burnet; research on the *Q* fever virus is one of the outstanding examples of the growing importance of the Hall Institute. All the time Kellaway had considerable anxiety for the Institute on the financial side, for its original endowment was not large by modern standards; but by unceasing efforts he persuaded the Government, the Rockefeller Institute and other semi-official bodies and various private donors to increase the resources at his disposal, and before he left he had succeeded in getting erected for the Institute a beautiful modern building in close proximity to Melbourne Hospital. In addition to all this, with the growth of his personal reputation, his wise counsel was increasingly sought on pathological matters for the Government. He was, for example, appointed chairman of the commission which investigated the death of some children at Bundaberg from poisoning with the until then unknown staphylococcal toxin, which had developed in an accidentally contaminated injection of prophylactic.

Kellaway was elected a Fellow of the Royal College of Physicians in 1928, Foundation Fellow of the Royal Australasian College of Physicians in 1938 and Fellow of the Royal Society of London in 1940. He received the Walter Parfitt Prize of the Royal Society of New South Wales in 1932.

During the Second World War, the Hall Institute diverted its work into researches on influenza, scrub typhus, Asiatic schistosomiasis, blood typing and transfusion, drying of serum and other problems of direct importance in war; and in spite of his official duties with the Army, Kellaway continued to control its activities. When he accepted the post of director-in-chief of research to the Wellcome Foundation, Ltd., in 1944, he had the satisfaction of having brought the Hall Institute into the front rank of the world's medical institutes, and he had complete confidence that he was leaving the Institute to the care of an outstanding successor—one of his own men.

In the Wellcome Foundation, Kellaway was responsible for the research policy of the organization in Great Britain, and acted in an advisory capacity for the research activities of the American subsidiary company in Tuckahoe, U.S.A. He had under him the directors of the Wellcome Laboratories for Tropical Medicine, of the Research Laboratories at Beckenham and of the Museum of Medical Science and of the Museum and Library for the History of Medicine. While delegating much to his colleagues, as was inevitable, he kept very close interest in all their activities. He found time to serve on outside scientific committees, where he was often in demand because of his own reputation. His particular interest in the Foundation was the development of chemotherapeutic research; an intensive drive for the discovery of new compounds of therapeutic importance was started. What is perhaps the most important result so far is the drug sold as 'Daraprim', which seems likely to be of considerable importance as a suppressive drug for malaria. This came as a result of collaboration between the Foundation laboratories in Tuckahoe and London. It was Kellaway who first brought these laboratories to close collaboration.

The field in which he now worked was very different from that in which he had worked. But the way in which he adapted himself to his new responsibilities was a tribute to his wide knowledge and versatility, and he carried the organization successfully through some very trying times.

Kellaway was an attractive character. His boyish enthusiasm, his kindness to his colleagues and his discerning courtesy to his lowliest subordinate, combined with his resoluteness and reliability and his power to see another point of view, stirred affection and respect in all who worked with him. His courage in his last illness will be an abiding memory for those who witnessed it. Our sympathy goes out to his wife and three sons.

J. W. Trevan

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We regret to announce the following deaths:

Prof. W. H. Hobbs, emeritus professor of geology in the University of Michigan, aged eighty-eight.

Prof. F. E. Weiss, F.R.S., emeritus professor of botany in the University of Manchester, on January 7, aged eighty-seven.

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# NEWS and VIEWS

## Royal Astronomical Society: Awards

The following awards of medals have been made by the president and Council of the Royal Astronomical Society: *Gold Medal of the Society:* Prof. S. Chandrasekhar, for his contributions to mathematical astrophysics; *Eddington Medal:* Canon G. Lemaître, for his work on the expansion of the universe; *Jackson-Gwilt Medal and Gift:* Mr. J. P. M. Prentice, for his contributions to the study of meteors.

## Royal Photographic Society: Centenary Celebrations

On January 20 the Royal Photographic Society will celebrate the hundredth anniversary of its formation, and to mark the day there will be a special ceremony at 11 a.m. in the Society's house at 16 Princes Gate, London, S.W.7, when the president of the Society will receive the representatives of a large number of other societies and kindred organizations. At 3.30 p.m. in the house of the Royal Society of Arts in John Adam Street, London, W.C.2, exactly a hundred years later to the very hour and in the same place where the inaugural meeting of the Royal Photographic Society was held, Mr. Bertram Sinkinson, vice-president, will give a lecture entitled "The Centenary of the Royal Photographic Society", in which he will reconstruct the atmosphere surrounding the Society's inception and give historical details of the incidents which led to these events. Mention will be made of the great part played by the first officers of the Society, namely, Sir Charles Eastlake, president, and Roger Fenton, honorary secretary, and the support given to them by the many ardent pioneers of photography at that time, including

W. H. Fox Talbot. The main theme of the lecture will be based on two papers delivered at the first ordinary meeting of the Society, which were, in point of fact, pronouncements of policy: Sir William J. Newton delivered a paper on "Photography in an Artistic View and its Relation to the Arts", and Roger Fenton made pronouncements on "The Mode in which it is Advisable that the Society should conduct its Labours". After discussing the main principles of these two papers and illustrating, with the use of lantern slides, the effect they had on the later development of the Society, Mr. Sinkinson will explain how, during the past century, the early policies of the Society, mainly based on our artistic concepts, have been adapted to meet the growing ramifications of the photographic process as they are now applied in their many forms to the service of the community through the arts and sciences. Admission to this lecture will be by ticket, obtainable from the Secretary of the Society. Finally, in the evening of the same day the Society will hold a banquet at Claridge's Hotel, London, at which T.R.H. the Duke and Duchess of Gloucester will be the guests of honour; included among the guests will be the president of the Royal Society, the president of the Royal Academy of Arts, and the presidents or vice-presidents of twenty-seven other learned and cultural societies.

## Scientific Research in British Industries during 1951–52

For the Royal Society Empire Scientific Conference in 1946 there were prepared "Some Notes on Current Scientific Researches in the United Kingdom" which included, besides particulars of academic research at the universities, some notes on research in progress at the Royal Technical College, Glasgow, the College of Technology, Manchester, the Royal Botanic Gardens, Kew, the Rothamsted Experimental Station, the John Innes Horticultural Institution, the Wellcome Research Institution and some other research establishments directly attached to government departments. This list was appended to the Conference report and was later used as the basis for the first edition (1948) of the British Council's "Scientific Research in Britain". This was intended only for the use of the British Council; but, in view of the interest aroused and requests received for copies, it was arranged that the Department of Scientific and Industrial Research would sponsor future editions and that the British Council would collect the material. The edition for 1949–50 was entitled "Scientific Research in British Universities", the scope being limited to researches in British universities and university colleges; but neither this edition, nor the similar off-set litho edition for 1950–51, was made generally available. The report for 1951–52 is issued as an open publication on sale to the public (pp. 485; London: H.M.S.O., 1952; 8s. 6d. net).

The contents are arranged by universities and university colleges, and are classified by subjects under the laboratory or department concerned, with the name of the director of research or research worker. Work at colleges of technology is excluded, although the College of Technology, Manchester, appears under the Department of Technology, University of Manchester, and the inclusion of work of like standing in other major colleges of technology would give the reader a more complete picture of the lines of research being carried out in university institutions throughout Great Britain. Only research which was pursued during the 1951–52 session and on which information has been published by the staff of the department within the past four years is included. An author index supplies information on the scientific activities of any particular research worker. The list constitutes a most useful reference volume for the industrial as well as the academic scientist and for libraries and information departments of research organizations.

## Technological Education in Great Britain

A report on "A Policy for Technological Education", which has been issued by the Association of Scientific Workers, urges that, besides the creation of a technological university, it is necessary to extend further existing university departments of technology, particularly for students who have done two years of science, and to make more use of the existing technical colleges. For this purpose, the report considers that it is essential to place the financial responsibility of selected major technical colleges on a body of the standing of the University Grants Committee so that these colleges may become responsible degree-granting institutions, either through affiliation to universities or independently. Adequate facilities for research should be provided as well as further post-graduate courses and vacation courses, to facilitate contacts between industry and the universities. In making these recommendations, the report does not deal with the critical question of how many technical colleges should be developed in this way, nor in its recommendations for further financial assistance from the State to those technical colleges remaining under the financial jurisdiction of local authorities does it deal with the question of student numbers, either from the point of view of the number of technicians required or from that of the existence of students of the requisite intellectual capacity and other qualities. The recommendations for expansion here appear to assume that the supply of such students is unlimited. Stress is rightly laid on the provision of adequate maintenance grants for full-time students accepted in institutions of higher technology, but the content of higher technological education is briefly discussed without specific recommendation, other than the extension of the 'sandwich' type of full-time course and broadening the scientific basis of part-time courses, as well as extending them as far as possible.

## Bibliography of Science in Latin America

The Centre of Scientific and Technical Documentation, an organization which, situated at Plaza de la Ciudadela 6, Mexico, D.F., was set up under the Unesco Programme of Technical Assistance, publishes monthly a *Bulletin* which contains translations into Spanish of the titles of all the original articles in the fifteen hundred scientific journals received regularly in the Centre from all parts of the world. The arrangement is by broad subject and sub-division within each subject, and then the listing is done alphabetically within each sub-division by the name of the first author. Papers published originally in Latin America are specially marked, and, starting with the September 1952 issue (1, No. 9), brief abstracts in French or English accompany these papers.

The series of publications under the title of "Scientific Institutions and Scientists in Latin America" has grown from strength to strength since it was first mooted at the Conference of Latin American Scientific

Experts, held in Montevideo in 1948, and now two more volumes have been published: "Ecuador, No. 1" (pp. 74, 1952), and "Argentina, No. 3" (pp. 150, 1952). In these two volumes, which are published by the Unesco Centre of Scientific Co-operation for Latin America, Montevideo, the usual practice is followed of including first a list of institutions, indicating their scope and resources and giving the names of their chief officials, and then an alphabetical list of scientific workers, in which the publications and field of work of each worker are listed. Further volumes are promised for Argentina.

## Study of Psychology in the United States

A STUDY of the development and status of research and education in psychology in the United States is being undertaken by the American Psychological Association and will be conducted in two parts: one part will be an evaluation of the status of psychological knowledge; and the other an analysis of occupational, educational and institutional relations of scientific psychology. The study will include a survey of methodology, theory and applications of psychology to determine the interrelationships among various branches of psychology and the importance of psychology to other scientific fields. Problems in psychological education, man-power, research support, communications and administration will also be examined. The project, which will cost about 40,000 dollars, derives its financial support from the National Science Foundation as another in the series of studies of specific fields of science which will assist the Foundation in developing a national science policy in the United States.

## Declassified Information on Atomic Energy Piles

A REVISED edition of a report from the Atomic Energy Research Establishment, Harwell, entitled "A Quantitative Study of Uranium-Graphite Lattices" (*R/R* 922; pp. 28+12 pl. London: H.M.S.O., 1952; 6*s*. net), by Profs. E. A. Guggenheim and M. H. L. Pryce, which was first issued on August 11, 1945, has recently been declassified and published. Calculations and results are given concerning piles of natural uranium rods arranged as a lattice in graphite. The quantity of uranium required for the pile to react steadily, the reproduction constant $k$, the square of the migration length $M^2$, and the Laplacian $(k-1)/M^2$ are particular quantities specified. The calculations show the effect of varying the radius $a$ of the uranium rods and the radius $b$ of the moderator cell. Both $k$ and the Laplacian each have a maximum, while the critical mass of uranium has a minimum. For a cylindrical pile with height equal to diameter, composed of uranium rods sheathed in 1·15 mm. of aluminium, arranged as a lattice in a graphite moderator and surrounded by a graphite reflector, the minimum quantity of uranium required is given as 26 tons. In this case $a = 1{\cdot}25 \pm 0{\cdot}10$ cm., $b = 11{\cdot}5 \pm 0{\cdot}50$ cm., and the width of the air-gap surrounding each rod $= 1{\cdot}5 \pm 0{\cdot}25$ cm. The effect of varying the air-gap is considerable, and the reasons for this are discussed. In a homogeneous pile the important factor is the proportion of uranium to graphite, and this is shown to remain approximately constant for variation in $a$, $b$ and the air-gap. The report includes fourteen tables, three diagrams illustrating the neutron cycle, the neutron distribution with an air-gap and with an aluminium layer and air-gap, and eighteen graphs. The above report was edited for the purpose of declassification by C. A. Rennie. Interested readers may well like to refer also to another A.E.R.E. report (*R/L* 5) by C. A. Rennie, entitled "Lecture Notes on Pile Theory" (*R/L* 5; pp. 29+3 pl. London: H.M.S.O., 1952; 5*s*. net), in which the basic nuclear design features of natural-uranium graphite-moderated thermal reactors are dealt with. This report includes references to published papers containing fuller treatment.

## Stomatal Behaviour in the Onion

SINCE the stomatal guard cells in the onion (*Allium cepa*) contain neither chloroplasts nor any visible quantity of starch, but do respond to changes in light intensity (which cannot be attributed to concomitant changes in temperature, etc.), the classical explanation of stomatal movement in terms of the starch ⇄ sugar mechanism cannot apply. Whether the hydrolysis of a soluble polysaccharide is involved has not yet been investigated. This interesting case of stomatal behaviour has recently been investigated by O. V. S. Heath (*New Phytol.*, 51, No. 1, 30; 1952), who has advanced various hypotheses to account for effects observed during the course of the relevant experiments.

## Conference on Plant and Animal Breeding

A ONE-DAY conference on "Plant and Animal Breeding" will be held under the auspices of the Joint Biology Committee and the Association of Agriculture at University College, London, on March 7. Mr. Alexander Hay, general secretary of the Association of Agriculture, will take the chair, and the speakers in the morning session will be Prof. L. S. Penrose, Galton professor of eugenics in University College, London, whose subject will be "Present-day Human Genetics", and Dr. Arthur Walton, deputy director of the Agricultural Research Council Unit of Animal Reproduction, Cambridge. The latter, in a talk entitled "Animal Genetics", will deal with the improvement of farm animals through modern breeding methods. In the afternoon Mr. W. B. Barker, of King's School, Wimbledon, will speak on "Teaching Genetics in School", and the conference will close with an address on "Plant Breeding Genetics" by Dr. G. D. H. Bell, director of the Plant Breeding Institute, Cambridge, who will describe the application of Mendelian principles to the work of increasing food production through crop improvement. The fee for the conference is 5*s*., and application should be made as early as possible to the Secretary, Joint Biology Committee, c/o British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1.

## Discussion on Collagen

AN informal discussion on the "Nature and Structure of Collagen", under the auspices of the Colloid and Biophysics Committee of the Faraday Society, will be held in the Wheatstone Physics Laboratory, King's College, London, W.C.2, during March 26–27. It is hoped that the response will be such as to allow for a small number of papers on the biological background to the subject, although the chief emphasis on this occasion will be given to physical and chemical studies of native and extracted or precipitated collagens. The biochemical studies of the amino-acid and polysaccharide contents of collagens of various origins now in progress in various laboratories are essential to the understanding of results obtained by means of the techniques of X-ray diffraction, electron microscopy, and infra-red

dichroism. It is hoped that researches in these fields will be reviewed and form the basis for discussion of models of the structure of collagenous fibres. Those wishing to attend or to take part in the discussion should communicate with Prof. J. T. Randall, King's College, London, W.C.2, as soon as possible.

## Medical Research Awards for Study Outside Britain

THE Medical Research Council is offering a number of fellowships and scholarships as follows: *Rockefeller* travelling fellowships (2,600 dollars a year or 3,600 dollars for married men) for graduates resident in Great Britain with previous research experience in medicine, to work at a centre in the United States or elsewhere abroad before taking up positions for higher teaching or research in Great Britain; *Eli Lilly* travelling fellowships of a similar nature to the Rockefeller awards; *Dorothy Temple Cross* research fellowships in tuberculosis (£650 a year or £900 for married men) for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Britain; *Alexander Pigott Wernher Memorial* travelling fellowships in ophthalmology and otology (£650 a year or £900 for married men) for suitably qualified medical graduates to study at a centre abroad before taking up positions for higher teaching or research in these subjects; and *French Government* exchange scholarships (45,000–90,000 francs a month, plus a marriage allowance payable in sterling) for young British graduates in medicine or science who have had some experience in a branch of medical science, to work in a research institution in France on some branch of medical science other than clinical medicine. All the above awards carry travelling allowances and other allowances, in addition to the stipend. Applications for the Rockefeller, Lilly and Cross fellowships must be received not later than March 15, and for the Wernher fellowships and French Government scholarships not later than March 31. Application forms and all further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

## Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: C. W. Benson (administrative officer, Nyasaland), biologist, Department of Game, Tsetse Control, Northern Rhodesia; M. D. Ashwin and T. G. Gudgeon (agricultural assistants, Nyasaland), agricultural officers, Nyasaland; J. R. Curry (senior agricultural officer, Federation of Malaya), chief field officer, Agricultural Department, Federation of Malaya; D. L. Downie (botanist, Uganda), tea research officer, Nyasaland; L. J. S. Littlejohn (agricultural officer, Tanganyika), chief soil conservation officer, Tanganyika; A. K. F. Nicol (assistant conservator of forests, Nigeria), chief conservator of forests, Sierra Leone; I. P. Tamworth (forestry officer, Hong Kong), assistant conservator of forests, Federation of Malaya; E. H. Jaques (senior geologist, Aden), geologist, Federation of Malaya; C. S. Cree (senior assistant conservator of forests, Northern Rhodesia), conservator of forests, British Honduras; D. B. Fanshawe (deputy conservator of forests, British Guiana), principal scientific officer (forestry research officer), Northern Rhodesia; J. W. Macaulay (senior veterinary research officer, Northern Rhodesia), senior veterinary research officer, Kenya; K. M. Francis (government statistician, Sierra Leone), government statistician, Gold Coast; D. P. E. Speldewinde (sub-assistant conservator of forests, Federation of Malaya), assistant conservator of forests, Federation of Malaya; H. Davidson, agricultural officer, Gambia; E. B. Dennison, D. C. Pickering, R. B. Skinner and D. J. Wheeler, agricultural officers, Nigeria; A. V. Haddon and P. Tuley, botanists (plant breeders), Federation of Malaya; M. G. Hawson and M. J. Strickland, agricultural officers, Federation of Malaya; B. G. Howston, plant breeder, Tanganyika; A. D. R. Ker, agricultural officer, Uganda; D. C. Mackenzie and F. P. Massey, agricultural officers, Sierra Leone; H. J. McLean, agricultural officer, Tanganyika; A. R. McWalter, soil chemist, Federation of Malaya; A. B. Rains, pasture research officer, Nigeria; R. D. Hockey and H. J. Richards, geologists, Nigeria; W. C. White, geologist, Somaliland Protectorate; W. Jackson, scientific officer, Sierra Leone; W. R. Stanton, senior scientific officer, Nigeria; P. G. Adlard and R. J. McEwan, assistant conservators of forests, Nyasaland; D. K. Bailey, geologist, Northern Rhodesia; P. B. H. Bailey, geologist, British Guiana; P. R. Browning, statistician, East Africa High Commission; R. D. T. E. Chandler, chemist, Federation of Malaya; Prince John Loewenstein, curator of anthropology, Raffles Museum, Singapore; C. J. Stratton, statistical officer, Gold Coast; R. S. Young, biochemist, Federation of Malaya.

## Announcements

H.R.H. THE DUKE OF EDINBURGH has accepted election to honorary membership of the Institution of Metallurgists.

OWING to the rapid expansion of work at the National Institute of Agricultural Botany, Cambridge, a new post there, that of deputy director, has been created, and Mr. A. Sandison has been appointed to fill it. Mr. Sandison, who was formerly assistant education officer for further education in Buckinghamshire, was born in 1914 and educated at Whitgift School and Trinity College, Cambridge, obtaining first-class honours in zoology in Part 2 of the Natural Sciences Tripos.

THE British Welding Research Association will hold its third summer school at Ashorne Hill, near Leamington Spa, Warwickshire, during April 27–May 2, the general theme this year being welding and fabrication. After introductory lectures on basic welding processes and materials, instruction will be given on welding design, modern processes and applications to productivity. In the afternoons the students will be split into five groups for specialized lectures pertaining to, respectively, the aircraft industry, shipbuilding industry, structural engineering, automobile and sheet-metal industries, and general engineering. Further details can be obtained from the Secretary, B.W.R.A. Summer School of Welding, British Welding Research Association, 29 Park Crescent, London, W.1.

THE Nuffield Foundation and the Nuffield Provincial Hospitals Trust, which are at present at 12–13 Mecklenburgh Square, London, W.C.1, and the National Corporation for the Care of Old People, at present at 33 Doughty Street, London, W.C.1, will be moving on January 22 to Nuffield Lodge (formerly Grove House, opposite St. John's Wood Church), Regent's Park, London, N.W.1. The Trust's Investigation into the Functions and Design of Hospitals will be at 33 Doughty Street, London, W.C.1, from January 22 until further notice.

# RESEARCH IN BRITISH COLONIAL TERRITORIES

"COLONIAL RESEARCH 1951–1952"* follows the form of last year's report. Besides the brief report of the Colonial Research Council, to which are appended a list of schemes approved for research grants, April 1, 1951–March 31, 1952, and the report of the Director of the Colonial Products Advisory Bureau for 1951–52, it comprises the ninth annual report of the Colonial Products Research Council, the eighth annual report of the Colonial Social Science Research Council, the seventh annual reports of the Colonial Medical Research Committee and the Committee for Colonial Agricultural, Animal Health and Forestry Research, the fifth annual reports of the Colonial Insecticides and the Colonial Economic Research Committee and annual reports of the Colonial Fisheries Advisory Committee on Fisheries Research, of the Director of the Anti-Locust Research Centre on Locust Research and Control, and of the Tsetse Fly and Trypanosomiasis Committee: lists of publications are appended to the several reports. The Colonial Research Council's report is, as usual, confined to matters not covered by the specialist committees, and its most important feature is the warning it sounds as to the effects of the uncertainty regarding the provision of Colonial Development and Welfare funds after the present Acts expire in March 1956. As the Council here points out, such uncertainty both makes the planning of long-term research impossible and is also hindering the recruitment of research workers for the Colonial territories.

The Council's reasonable request for an early clarification of the position is one which should receive prompt response from the Government, and should be carefully noted by scientific workers as well as by the Parliamentary and Scientific Committee. Little is said in these reports about other difficulties in recruiting scientific workers; seventeen research appointments were made during the year, and about forty officers in some ninety posts in the Colonial Agricultural, Veterinary and Medical Services have been declared suitable for transfer to the Colonial Research Service. The Council in this report stresses the importance both of direct contact between research organizations and institutions in Great Britain and the Colonial territories, and of visits of members of the various research advisory committees to the territories where the schemes sponsored by the committees operate.

As was forecast in last year's report, there was a substantial reduction in the number and size of research schemes made during the year: some thirty-six new schemes and fifty-three supplementary schemes, involving grants totalling £868,851, brought the total allotted to Colonial Development and Welfare Schemes to a net expenditure and commitment of £10,140,000 at March 31, 1952, of which £9·94 millions is chargeable against funds provided under the 1945 and 1950 Acts. Additional assistance provided by Colonial Governments or industry since 1940 is estimated at about £3 millions. Of the gross allocation of £11,100,000, about 32·7 per cent has been for agricultural, animal health and forestry schemes, 13·9 per cent for medical research, 13·8 per cent for fisheries research, 11·7 per cent for tsetse and trypanosomiasis research, 8·8 per cent for social science and economic research, 6·2 per cent for insecticides research, 4·6 per cent for research sponsored by the Colonial Products Research Council and 3·5 per cent for anti-locust research. About 39·0 per cent of the gross allocation has been for schemes to benefit the East African territories, 18·3 per cent for the West African group, 11·1 per cent for the South-East Asian territories and Hong Kong, 8·7 per cent for the West Indian Colonies, British Guiana and British Honduras and 6·2 per cent for the Central African territories (Northern Rhodesia and Nyasaland). Schemes approved during the year besides those recently noted (cf. *Nature*, 170, 311; 1952) include £28,750 for the Anti-Locust Research Centre and its extra-mural research, £31,500 for physiological and biochemical research at Makerere College, Uganda, £26,620 for the East African Agriculture and Forestry Research Organization, £24,403 for the Nutrition Field Station, Fajara, Gambia, and £17,500 to enable clove research in Zanzibar to be extended until August 31, 1953.

Work under four of the Economic Co-operation Administration projects mentioned in last year's report was started or continued in 1951–52. An American plant-breeder visited Nigeria to investigate the breeding of improved grain sorghums and maize, and an entomologist was secured for research in Northern Rhodesia into the control of ticks affecting livestock. The African Studies Branch of the Colonial Office is undertaking surveys of particular subjects to meet current Colonial Office needs, and a complete survey of the development of local government in the African territories since 1947 began to appear as supplements to the *Journal of African Administration* in January 1952. Mr. Ian Small, the newly appointed director of the West African Building Research Organization, was proceeding to the Gold Coast in the summer of 1952, and Mr. G. A. Atkinson, the Colonial building research liaison officer, who has now visited twenty-five Colonial territories, visited Hong Kong and the South-East Asian territories and also Aden and Cyprus during January–May 1952. His report on his visit to the Caribbean area was presented during the year, and a review of aided self-help housing, based on information gained during the tour, was circulated to all Colonial governments. Mr. Atkinson reached the conclusion that little or no organized scientific research into building problems is possible in the area in the immediate future. Much could be done, however, to improve building materials by making technical information more readily available and by providing better facilities for training building technicians and for testing materials.

Publication of Volume 3 of the "Demographic Survey of the British Colonial Empire" is expected early in 1953. Censuses were taken during the year

* Colonial Office. Colonial Research 1951–1952: Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director of Anti-Locust Research Centre. (Cmd. 8665.) Pp. ii+253. (London: H.M. Stationery Office, 1952.) 6s. 6d. net.

in North Borneo and Gambia and, for the non-African population and for Africans in employment, in Northern Rhodesia. The Directorate of Colonial (Geodetic and Topographic) Surveys moved into new headquarters at Tolworth in June 1951; but little progress is reported in recruiting field-survey staff. A chain of triangles has been reconnoitred, beaconed and observed from Eastern Uganda (near Mount Elgon) down the east side of Lake Victoria to Tanganyika. Most of the southern half of Basutoland has been covered with secondary triangulation. An additional twenty geologists were appointed during the year, and the strength of the overseas scientific staff was 180 in 1951, compared with 58 in 1947, although there is still a shortage of experienced geologists trained in mapping, petrology and mineralogy. The total area geologically mapped during the year increased considerably. Research continues at various institutions in the United Kingdom on the economic production of Columbian minerals, iron ore and apatite from the soils surrounding the Sukulu carbonatite ring-structure in Uganda. Good progress is being made in the examination of coalfields in Tanganyika, and the report welcomes the growing practical interest of the universities in Great Britain in Colonial geology.

Investigations undertaken in Uganda by the British Paper and Board Industry Research Association on the suitability of local fibres for incorporation in a pulp for the manufacture of a kraft-type of paper for containers have given promising results, and a paper entitled "Some Notes on the Durability of Paint in Tropical Climates" has been prepared, with particular reference to the humid climate of Singapore. Progress continued in the installation of *radiosonde*/radar wind stations for the study of upper-wind conditions, and regular observations to a height of 60,000 ft. are now made by stations established at Aden, Gibraltar, Lagos, Malta and Nairobi. In the oceanographic research to which the Colonial Office contributes, some new instruments are being developed, including a simple method of recording the changes in depth of a mid-water trawl, by measuring the changes in pressure in a rubber bag attached to the trawl, and connected to the ship by a reinforced hose-pipe. Discovery by the R.R.S. *William Scoresby* of the breeding ground of the pilchard (*Sardinops sagax*) enabled detailed information to be supplied to Colonial fishery officers in West Africa. The work of the Colonial Liaison Officer at the Road Research Laboratory in Britain is attracting increasing attention from Colonial engineers, and a report is being prepared on his visit in October and November 1951 to Northern Rhodesia and Nyasaland, where the same road problems, broadly speaking, were met as in East and West Africa, though the soils appear to present less difficulty than in East Africa. It is proposed to place the work of the Colonial Products Advisory Bureau, which covers much the same field as that of the Colonial Products Research Council, under a common directorship with the latter body early in 1953. During 1951–52 the Bureau has carried out work on the chromatographic separation of the active principles of pyrethrum, on distilled lime oil from Zanzibar, gum arabic from Tanganyika and the Somaliland Protectorate, cattle hides from East and West Africa, the drying of goat skins, the utilization of *Brachystegia* wood from Tanganyika for paper-making, and the tanning properties of the barks of *Eucalyptus robusta* and *E. saligna* from Uganda.

The ninth annual report of the Colonial Products Research Council stresses the value of the work of the Colonial Microbiological Research Institute and of the work carried out there on the fermentation of the cocoa bean. The results already obtained are likely to prove of immediate value to plant-breeders, as they enable commercial evaluation to be made of small samples of beans. A provisional patent has been taken out to cover the preparation of the antibiotic comirin. Although much work is required to determine the most efficient method of preparation and little is yet known of its chemical structure, clinical trials both in Trinidad and in Jamaica have indicated that the fungus skin infections *Tinea corporis*, *T. cruris* and *T. interdigitale* respond to topical applications of comirin, and that it is also effective in cases of 'tropical ear' infection due to *Aspergillus flavus* or *Candida parapsilosis*, but not when the infection was caused by a Gram-negative, motile or non-motile short rod. An investigation is being undertaken on the possibility of growing in the tropics a yeast with a high ergosterol content.

The Hankey Culture Collection now contains more than 500 specimens, of which 84 were isolated from Trinidad sources during the year; 60 cultures were supplied to scientific institutions and commercial firms. With the completion of the Sugar Technological Laboratory in Trinidad, Prof. L. F. Wiggins has been able to examine the possible economic uses of some of the products derived from sugar. Two hydrocarbon solvents available locally proved satisfactory substitutes for benzene in extracting the wax from the filter mud, and by treating the crude wax with fusel oil, a light yellow or grey wax, melting point 78°–80°, which appears to be suitable for various industrial purposes, can be readily obtained. The possibility of utilizing, on a manufacturing scale, the improved processes for the preparation of lævulinic and lactic acids from sucrose worked out in the University of Birmingham is now being studied in Trinidad, and a successful process, using an alkaline solution, has been discovered for isolating the cellulose from bagasse in a form suitable for the manufacture of paper.

Equipment has at last been supplied for the special laboratory at the Forest Products Research Laboratory, Princes Risborough, and a series of hardboards with good properties has been obtained from Wallaba wood. Work on the constituents of Colonial hardwoods being carried out in the University of Nottingham in collaboration with the Princes Risborough Laboratory is expected to throw light on the problem of the resistance of timbers to insect and fungal attack. Further carbohydrate investigations carried out in the University of Birmingham have succeeded in preparing tripotassium α-D-glucuronate-1-phosphate, which is already proving of value in the enzymic syntheses of polyglucuronides. In further work on polysaccharides, evidence has been obtained that dextran is a mixture of materials with a wide range of molecular weights, and that while the dextran from *Betacoccus arabinosaceus* has an average chain-length of six to seven glucose units, the cross-linking is not of the 1 : 4 type. Investigations on the production of bacterial cellulose from sugar have reached the stage when pilot plant trials are desirable.

Improved methods have been developed for the isolation and purification of starch-metabolizing enzymes, and a clearer definition of their functions is now possible. The *R*-enzyme possesses only the

function of irreversible hydrolytic scission of the branch links in amylopectin. The *Z*-enzyme is a β-glucosidase, and with its aid it has been found that amylase contains branch linkages. The *Q*-enzyme has been recognized as a transglucosidase. An excellent oil has been extracted from the eighteen tons of heat-dried oil-seeds of *Tetracarpidium conophorum* received from Nigeria and is now being distributed in the paint industry for technical evaluation. Progress is reported in the study of the germination factor of *Striga*, and highly satisfactory results were obtained in Nigeria with a new machine for harvesting *Hibiscus cannabinus*, and accordingly further trials are being made with jute in British Guiana.

The eighth annual report of the Colonial Social Science Research Council refers to the great restraint which the Council has had to exercise in making new grants. Since October 1, 1951, the Council has had to operate within a limit of £325,000 until March 31, 1956, and on March 31, 1952, only some £200,000 was uncommitted. Accordingly, it was necessary to refuse applications for new grants which were not already receiving considerable financial support from other sources. Although the recruitment position for experienced research staff improved, difficulty is still being encountered in recruiting senior staff capable of organizing research, and in such special categories as demography and law. Much of the present report is occupied by a retrospect of the work of the Council since 1945, and there are appended to it annual reports for 1951–52 from the East African Institute of Social Research, Makerere College, the West African Institute of Social and Economic Research, Ibadan, the Rhodes–Livingstone Institute, and the Institute of Social and Economic Research, University College of the West Indies, as well as a list of publications by research workers assisted by the Council.

Commenting on the progress of Colonial studies in British universities, the Council refers to the work of the Department of Anthropology in the University of Manchester, which is closely associated with the work of the Rhodes–Livingstone Institute on Central African Studies, the work on race relations carried out under the auspices of the Department of Anthropology in the University of Edinburgh, and to the analysis of the social organization and types of society in the highlands of New Guinea and the studies of the appearance of cargo cults in the Pacific Islands and of the Pacific islander in commerce and industry being carried out by the Department of Anthropology of the Australian National University. The Survey of African Marriage and Family Life has been completed and is now in the press. Other reports in the press are Mr. J. N. D. Anderson's synoptic survey of the present position of Islamic law in the British African territories and Aden, Prof. C. M. Dohe's study of the Bantu languages of Southern Africa and the West Indian volume of the late Dr. Kuczynski's "Demographic Survey of the British Colonial Empire", while numerous other investigations are being prepared for publication. The East African Institute of Social Research has completed a survey of the European, Indian and African inhabitants of Jinja township and continued village surveys of immigrant labour in Buganda. A study of the present method of selection and training of African leaders in East Africa is proposed, as well as a survey of the Indian community in and around Kampala. At the West African Institute of Social and Economic Research, the inquiry into the Nigerian monetary and banking system is being completed and also that into Yoruba social and economic organizations. Definite proposals have been made regarding the functions of the Institute in relation to the Nigeria produce-marketing boards. The major event at the Rhodes–Livingstone Institute was the appearance of its first major publication, "Seven Tribes of British Central Africa". The Institute of Social and Economic Research, Jamaica, reports progress in the projects for the preparation of national income estimates, the determination of the trend in consumption patterns in Barbados and on experiences of management in the adaptation and training of Jamaican industrial workers.

(*To be continued*)

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# INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS

## MEETING IN SHEFFIELD

THE summer meeting of the Industrial Radiology Group of the Institute of Physics was held at Crewe Hall, Sheffield, during July 3–5. The success of the meeting was in no small way due to J. F. Hinsley and H. S. Peiser, who were responsible for the local arrangements, and to the staffs at Crewe Hall and at the various companies and institutions visited.

A day and a half were devoted to lectures, the opening session on "Training in Industrial Radiology" being given in two parts, the first by Mr. J. C. Rockley, of the Aeronautical Inspection Directorate, Harefield, and the second by Mr. J. D. Hislop, of Solus-Schall, Ltd. Mr. Rockley pleaded for a longer training course than is at present available for industry, with a recognized award, and spoke of what is being done by the exploratory committee of the City and Guilds of London Institute, to which the Institute of Physics has made recommendations.

Mr. Hislop thought that the maximum tuition in the time available in a part-time course can only be given if a good deal of this is devoted to theoretical work. In dealing with the special problems of weld examination, he put forward a plea for standards of interpretation which could be incorporated in any final training scheme and stressed the importance of correct identification and of orderly reporting. He thought that the training of a radiographer is essentially a long-term one, and suggested that managerial staff should become more familiar with the limitations of the method.

The first paper during the afternoon was given by Dr. R. Jackson, of the British Coal Utilization Research Association, on "The Presentation of Results in Radiography with Special Reference to the Terminology of Casting Defects". Dr. Jackson stressed the need for as good a radiograph as could be obtained, followed by careful interpretation, with as full information about the casting as possible in advance. He concluded with a description of the many difficulties which had been met in drawing up the proposed British Standards Institution terminology.

The second afternoon paper had the title "Economic Aspects and Administration of an Industrial Radiology Department" and was a joint paper by E. W. Colbeck, F. Cousans, H. S. Peiser and J. R. Rait (all of Hadfields, Ltd.). Mr. Peiser, who delivered the lecture,

dealt particularly with radiography in the laboratory of a steelworks. Radiography, he said, could be divided into three groups, namely, inspection, *ad hoc* problems, and investigations of manufacturing techniques. In the first, 100 per cent inspection is only justified if failure in service would cause destruction of a valuable engineering unit or endanger life. The chief economic considerations involved were briefly discussed. In dealing with *ad hoc* problems on which the X-ray department has come to the aid of the foundry, Mr. Peiser mentioned the determination in weld repairs of the extent of the defect and the quality of the repair when it has been made, and problems arising in the examination of inaccessible plant or equipment. In dealing with the investigation of manufacturing techniques, he said that this type of investigation is the most valuable economically and, in addition, from it better products usually result; he gave as an example from the hundreds undertaken the elimination of shrinkage cavities. Mr. Peiser concluded with some remarks on the economic operation of a radiographic department.

On the evening of July 3, Dr. O. Vaupel, of the Röntgenstelle, Material Prüfungsamt, Berlin, lectured on the subject of "The Standardization of Radiology in Germany". Dealing specially with X-ray and gamma-ray techniques, he said that new quality standards for X-ray and gamma-ray pictures would be published shortly under standard *DIN* 54110, which would replace the present standard *DIN* 1914. Dr. Vaupel next described the wire penetrameter, consisting of wires of the appropriate material embedded in thin rubber, four gauges being required to cover thicknesses up to 3½ in. Since none of the orthodox types of penetrameter is capable of showing up small differences in defect sensitivity because the gaps (for example, between adjacent wires) were too wide, E. A. W. Müller in 1942 invented a more accurate penetrameter known as the 'bacillæ test', an ingenious device in which short lengths of randomly distributed wires are contained in nine boxes embedded in low-adsorption material, the whole containing thirty-one wires of the same diameter, for example, 0·4 mm. The observer draws the positions of the wires as seen on the film and compares the result with their true positions. This is repeated for wires of different diameter, and the number of observed wires is plotted against the diameter, extrapolation giving the diameter necessary for thirty-one wires. On the subject of the standardization of magnetic crack testing, Dr. Vaupel said that the importance of this method can be judged from the fact that in 1944 there were in Germany as many magnetic crack detectors in use as X-ray equipments. The methods by which magnetism is induced in the specimen had been standardized as well as the direction of the resultant magnetism. There is also a standard test for magnetic inks. Dr. Vaupel also described the Berthold magnetic penetrameter which indicates the efficiency of a magnetic test.

The first paper at the morning session of July 4 was read by Mr. J. F. Hinsley, of Edgar Allen and Co., Ltd., and had the title "The Radiography of Castings". Starting with a review of the casting processes, the subsequent chain of events in the foundry was described. To talk with the foundryman the radiographer needs to understand his terms, and these were explained. The design of castings was next discussed, in particular the formation of defects during the solidification process, and it was shown how the radiologist can help in this connexion, as also in the feeding process.

The last lecture, on July 4, was given by Mr. G. T Harris, of William Jessop and Sons, Ltd., who spoke on "Non-Destructive Testing in a Steelworks", which for the purpose of his talk he divided into three sections, namely, identification, checking mechanical and physical properties, and the detection of surface and internal defects. In the first section can be placed the spectrograph and its simplification, the spark test with a grinding wheel; microhardness testers and thermo- and tribo-electric methods were also described. In the second section Mr. Harris spoke of automatic thickness gauges and then described the core loss comparator, in which, by placing a coil round the bar under test and measuring the core loss, quality differences are at once obvious. In discussing magnetic crack detection, the effect of the direction of the field was shown. Inspection by penetrating oil has been improved by using fluorescent oils, and an American method called 'Dy-chek' was referred to. Another method has the advantage of using a water-soluble oil which is easily removed. Electrolytic etching is widely used, said Mr. Harris, as it is a very sensitive method of detecting surface cracks. He discussed the correlation of the results of ultrasonic flaw detection and radiology, and stated that it is difficult to estimate the size of a defect by the ultrasonic method, though he thought that automatic scanning would be an advantage. Speaking of radiology, Mr. Harris said that developments needed are X-ray equipments able to penetrate ten inches of steel, scanning of large specimens by counters, Xero-radiography and the amplification of fluorescent images by image converters.

B. N. Clack

## MECHANISM OF PHOTOGRAPHIC SENSITIVITY IN SILVER BROMIDE

IT has been shown recently by Loening[1] that pure silver bromide in the form of an aqueous sol has only a very slight sensitivity to light as judged after development. Sensitization can be achieved by adding silver ions or gelatine or substances such as sodium nitrite to the sol. Ordinary photographic emulsions have already the sensitivity conferred by gelatine, and there are three well-established methods[2] of obtaining further gains of sensitivity, depending on the addition of one of three substances: reducing agents, gold salts and sulphur compounds. These substances probably react with the silver bromide to form minute quantities of silver, gold and silver sulphide respectively at the grain surfaces: at any rate, that is the simplest supposition. All this refers to 'chemical' sensitization, as distinct from extension of spectral sensitivity by dyes.

According to the theory of the photolysis of silver bromide put forward in 1938 by Gurney and Mott[3], the absorption of a light quantum by silver bromide removes an electron from a bromide ion, leaving a 'positive hole'. The electron and the hole should both be highly mobile. If silver particles are present, they become negatively charged by trapping electrons and grow by attracting the mobile interstitial silver ions that are naturally present in the crystal (Frenkel disorder). This theory still holds the field, more recent attempts based on the assumption of Schottky disorder having now been abandoned[4]. As applied

to the formation of latent images, however, the theory is incomplete: one has to explain how the positive holes are prevented from recombining with the electrons and how the first electrons are trapped if no silver is initially present. What is lacking is evidently a theory of sensitization, and the question arises: Do the sensitizers mentioned function as electron traps, or positive hole traps, or both?

In a lecture given on November 20 before the Scientific and Technical Group of the Royal Photographic Society, Dr. J. W. Mitchell described a series of elegant experiments on the point carried out by himself and collaborators in the University of Bristol. The complications of photographic emulsion work were avoided by using pure dry monocrystalline plates of silver bromide and applying the sensitizer (silver, gold or a metallic sulphide) directly in a very thin uniform surface-layer by vacuum evaporation. The plates were about 1 cm. square and 0·01 cm. thick, with the crystallographic [100] axis approximately perpendicular to the square face. An ordinary metol-hydroquinone developer was used, with a little gelatine added to prevent excessive fog. Unexposed unsensitized specimens gave only a slight irreducible fog in the form of small oriented silver crystals scattered over the surface, as observed in previous single-crystal work by Dankov[5] and Boissonnas[6]. Exposure to light produced no further developable effect, even when sufficient to produce visible (internal) separation of silver. A developable latent image was produced, however, by exposure under a solution containing a bromine acceptor.

By means of slits and masks, the deposition of sensitizing substances and the exposure to light were restricted to well-defined circular or rectangular areas of the specimen. Areas bearing $10^{15}$ silver atoms per sq. cm. (about one monolayer) were blackened by development without exposure, the edges appearing well defined. Specimens bearing $10^{14}$ silver atoms per sq. cm. gave only the normal irreducible fog without exposure, but were blackened in certain areas by development after exposure—that is, they were sensitized but not fogged by the deposited silver. This blackening or latent-image formation was expected to occur only in the areas both silvered and exposed to light, but the result was quite different. The blackening appeared only in the unexposed areas, and spread beyond the silvered areas, the spreading being greater at a greater distance from the exposed area: with sufficient exposure the entire unexposed area became blackened. Essentially the same phenomena were observed with gold and with arsenious, antimony and thallous sulphides (silver sulphide, not being stable enough for evaporation, was not tried).

If the sensitizers in these experiments acted mainly as electron traps, the blackening would presumably have been confined to the sensitized areas. It seems that the phenomena can only be explained by supposing that they act as positive-hole traps, that is, they react with the bromine, which is quite reasonable from a chemical point of view. If some of the bromine is removed in this way, a surplus of electrons remains, and apparently no special electron traps are then needed to ensure the formation of latent-image silver specks, for the latent image appears mainly on the naked silver bromide surface. The mobility of the electron being about twice that of the positive hole explains why the image is produced far from the exposed area, in which a surplus of positive holes will be left. The space charge produced by the electrons travelling faster than the holes would produce a field urging interstitial silver ions into the electron-rich regions. Dr. Mitchell did not, however, attempt to give a complete theory of the phenomena.

It appears then that silver, gold and metallic sulphides all sensitize by the same mechanism, that the function of each is to react with halogen, and that no special electron traps are needed for sensitivity. In the case of silver sensitization, the capture of positive holes by the silver permits the formation of new silver elsewhere by the electrons and interstitial ions, and one might say that in effect the latent image is formed by redistributing the silver initially present. These tentative conclusions, though they may not be directly applicable to the sensitization of ordinary emulsions, are of obvious interest to the photographic chemist and represent a radical revision of earlier thought on the subject.

[1] Loening, E. E., in "Fundamental Mechanisms of Photographic Sensitivity", 149, ed. J. W. Mitchell (London: Butterworths Scientific Publications, 1951); *Phot. J.*, **92B**, 126 (1952).
[2] Lowe, W. G., Jones, J. E., and Roberts, H. E., in "Fundamental Mechanisms", 112.
[3] Gurney, R. W., and Mott, N. F., *Proc. Roy. Soc.*, **A, 164**, 151 (1938).
[4] Mitchell, J. W., *Sci. Indust. Phot.*, **19**, 361 (1948); *Phil. Mag.*, **40**, 249, 667 (1949); "Fundamental Mechanisms", 242.
[5] Dankov, P. D., and Kochetkov, A. A., *C.R. Acad. Sci., U.R.S.S.*, **26**, 785 (1946).
[6] Boissonnas, C. G., *Sci. Indust. Phot.*, **20**, 361 (1949); *Experientia*, **5**, 282 (1949); "Fundamental Mechanisms", 36.

# THE FORESTRY COMMISSION

## REPORT FOR THE YEAR 1950–51

THE thirty-second annual report of the Forestry Commission records the activities of the Commission for the year ending September 30, 1951*. During this time the passing of the Forestry Act 1951 took place, and the year also marked the end of the first post-war quinquennium. The progress of private forestry, and the dedication schemes and the acquisition of land during the year are worthy of notice.

The Forestry Act 1951 was passed during August 1951, and its main provisions, which relate to the maintenance of reserves of growing trees in Great Britain, came into force two months later. Since the beginning of the Second World War, fellings had been controlled by statutory instruments under Defence Regulation 68. This was not intended to be permanent; nevertheless, the timber resources of Great Britain in both conifers and hardwoods were alarmingly small, and unchecked felling could not be countenanced. The Forestry Commission is therefore charged by the Act with "the general duty of promoting the establishment and maintenance in Great Britain of adequate reserves of growing trees". To carry this out the Commission is required to consult with the Home Grown Timber Advisory Committee, consisting among others of those appointed on the advice of woodland owners and the timber trade. The Act also provides for the maintenance in each conservancy of a regional advisory committee, "certain members of which are appointed after consultation with the above organizations and with the forestry societies, for the purpose of advising the Commissioners as to the performance of their functions under the provisions of the Act relating to licensing and compulsory felling". The Act prohibits the felling

* Forestry Commission: Thirty-second Annual Report of the Forestry Commissioners for the Year ending September 30th, 1951. Pp. 82. (London: H.M.S.O., 1952.) 3s. net.

of any growing tree (apart from certain exceptions such as trees less than a given diameter, garden and orchard trees and a licence-free allowance of 825 cu. ft. per quarter) unless a licence has been granted by the Commissioners.

Apart from the Forestry Commissioners and the staff of the Forest Department proper, there are no less than three National Committees (England, Scotland and Wales), eleven Regional Advisory Committees (five for England, four for Scotland and two for Wales) and a Home Grown Advisory Committee—a total of fifteen committees to assist in carrying out the forestry work of a comparatively small island.

One important provision of the Act is that the Commissioners have now the power to add replanting of the area to a felling licence. By establishing the principle that it is contrary to the public interest that forest land should be cleared and then allowed to lie derelict, the Act will check the further accumulation of unproductive woodland areas.

The area of forest planted during the year was 57,164 acres, of which 17,491 were in England, 26,960 in Scotland and 12,713 in Wales. The total area of land acquired during the year was 113,200 acres, of which 56,000 were classed as plantable. Of the latter, 16,000 were in England, 33,000 in Scotland and 7,000 in Wales.

It is estimated that private owners planted 12,300 acres, of which 6,300 acres were planted with the aid of grants. Under the dedication scheme deeds were completed with seventy-nine owners in respect of 37,010 acres of woodland. The planting and maintenance grants have been revised and increased. During the quinquennium a total area of 138,000 acres of the woods planted since 1921 has been thinned, and it is estimated that during the same period 38 million cu. ft. of poles and timber (roughly a million trees) have been extracted from these new public forests, and a small return on the capital outlay is being obtained.

An additional national forest park, named Loch Ard, was set up in the lovely Trossachs district of the Scottish Highlands. This must be one of the most beautiful of all the national forest parks so far established.

E. P. Stebbing

## COMMONWEALTH OBSERVATORY, CANBERRA

### REPORT FOR 1951

THE report of the Commonwealth Astronomer for the year 1951* covers the activity of the Commonwealth Observatory, Canberra, during the twelve months up to December 31, 1951. During this period sunspot sketches were obtained on 294 days, and solar radio-noise observations on a frequency of 200 Mc./s. were continued. Transit observations with the small reversible transit instrument gave 251 determinations of clock error obtained on 216 nights. Random errors from the sidereal pendulum clock have been eliminated by determining the error directly of one of the mean-time quartz-crystal clocks. Time services were originated four times each day, and some preliminary work has been carried out with the view of supplying a time service for South Australia.

* Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1951. Pp. 5. (Canberra: Commonwealth Government Printer, 1952.)

Dr. G. E. Kron, of the Lick Observatory, assisted by Dr. S. C. B. Gascoigne, using the Reynolds 30-in. reflector, carried out a programme of red and infra-red measurements, utilizing a refrigerated cæsium oxide cell, and determined the magnitudes at effective wave-lengths 8250 A. and 6300 A. of stars in standard regions *D*2, *C*4, *C*6, *D*6, *C*8, *D*10, *C*12; of all nearer stars within about 12 parsecs (and this part of the programme included accurate photometric observations of Proxima Centauri); and of certain bright stars included in previous Mt. Stromlo programmes. In addition to this, they worked for eighteen nights on various objects in the Magellanic Cloud, using a refrigerated 1P21 multiplier. The magnitude limit was about 15·5, and all nine Cepheids examined were appreciably bluer than galactic Cepheids of similar period. Dr. O. J. Eggen, using an 1P21 multiplier on the Oddie telescope, measured colours and magnitudes of stars of known parallax brighter than photographic magnitude 11·0 and also of Cepheids brighter than magnitude 10·0. Objects of some interest were also observed, and *HD*223045 showed a light variation of 0·75 mag. with a period of only 80 min.

The contractors for the 74-in. reflector informed the director of the Commonwealth Observatory that the mounting was ready for dispatch from London, where it had been on exhibition during the Festival of Britain, and the mirror, which has been lightly polished, shows a good figure. Notable progress has been made with the building for the 50-in. (the old Melbourne 48-in.) reflector, and the mirror, by the firm of Cox, Hargreaves and Thomson, has arrived in Canberra. It is proposed that this instrument be initially set up in a Schmidt–Gregorian form prior to the completion of the Schmidt correcting plate and the construction of the plate-holder and tube for the Schmidt telescope. A 40-in. aluminizing tank is in use, and all the larger astronomical mirrors have been coated with aluminium.

The issue of regular monthly publications of the Ionospheric Prediction Service has been maintained. In addition to the analysis of data from Macquarie Island, some results have been obtained from the Townsville Station, which has been re-occupied. The new building for the Hobart Station has been completed, and power lines and aerials were in course of erection. Attempts are being made, in collaboration with the Overseas Telecommunications Commission, to re-introduce the system of storm warnings.

A supplement to the report for 1950*, which marks the twenty-fifth anniversary of the commencement of the observational work of the Commonwealth Observatory, takes the form of a history of the Observatory to the end of 1950. Originally known as the Commonwealth Solar Observatory, which started on January 1, 1924, with the appointment of Dr. W. G. Duffield as first director, actual observations commenced at Canberra in the following year and at Mt. Stromlo in 1926. The history of the foundation extends back nearly twenty years from the latter date, and the details connected with this are very fully set out in the supplement in a review of about seven thousand words. At the end of this there are several illustrations and photographs, the former showing various details of the Observatory, and the latter giving general views of the Observatory, of the Reynolds 30-in. reflector arranged for photo-electric work, and of a corner of the machine shop. This supplement forms very interesting reading.

* Supplement to the Report of the Commonwealth Astronomer for the Year 1950. Pp. 11+7 plates. (Canberra: Commonwealth Government Printer, 1951.)

# FORMS OF INSECTICIDE-RESISTANCE IN HOUSEFLIES AND BODY LICE

By Dr. J. R. BUSVINE

London School of Hygiene and Tropical Medicine

## Investigations with Houseflies (*Musca domestica*)

IN 1951, I described the distinctive characters of two laboratory strains of insecticide-resistant houseflies, originally obtained from Italy and Sardinia[1]. These have provided the material for some attempts to segregate, by selective breeding, different kinds of resistance which may occur in houseflies. Batches of flies in successive generations were exposed to various insecticides (by the methods described in 1951) and the lines maintained from survivors. The numbers exposed in each generation were about twenty-five unmated of each sex or forty to fifty fertilized females; and the aim was to adjust the dose to obtain a kill of 80–90 per cent. Owing to the rather small numbers available, failure to increase the resistance of a sub-colony may sometimes have been due to the chance absence of particular genes from the population sample chosen. Therefore, while a positive result was of interest, a negative one was of dubious significance.

The results of check tests, done at intervals of weeks, and sometimes months, showed that, in the absence of selection, the various strains and sub-colonies maintained their particular characteristics over many generations with little change.

The original strains were: an Italian colony (*I*), a Sardinian one (*S*) and a non-resistant colony (*N*). The lines selected from them were as follows:

(1) *Sub-colony* (*N* × *S*). Susceptible flies were crossed with those of the *S* strain and the progeny selected for resistance to γBHC. The surviving males were back-crossed with susceptible females and the progeny again selected for resistance to γBHC. This was repeated twice more with the following results. Selection with γBHC had maintained γBHC-resistance in the strain, together with some tolerance of chlordane and dieldrin; while the repeated back-crossing with susceptibles had lowered DDT-resistance practically to normal.

(2) *Sub-colony* (*Ch*). A line derived from the *I*-strain was selected for resistance to chlordane on six occasions over a period of eleven generations. There was an enormous rise in resistance to chlordane (× 500), to dieldrin (× 300) and to γBHC (× 60) with only a small increase in resistance to DDT (× 2·2).

(3) *Sub-colony* (*P*). An attempt was made to increase resistance to pyrethrins in a sub-colony of the *I*-strain. Batches were exposed to partially lethal concentrations on seven occasions over a period of twelve generations, with only a slight increase in resistance (× 1·3). Afterwards, flies of this sub-colony were twice selected for resistance to paralysis by DDT; this had the incidental effect of somewhat augmenting resistance to pyrethrins.

(4) *Sub-colony* (*SS*). Some flies derived from the *S* strain were selected for resistance to kill by DDT in two successive generations. This was in order to raise the average lethal dose to a level comparable with that of the *Ch* sub-colony.

(5) *Sub-colony* (*S.k-d*). My colleague, Dr. C. M. Harrison, kindly allowed me to use some flies of a sub-colony which she has been selecting for resistance to DDT-paralysis. This colony was derived from the *S* strain and selected over eleven successive generations by breeding from flies not readily knocked-down by DDT. The result of this selection (which will be reported more fully elsewhere) was highly successful.

*Investigation of selected strains.* After the selection procedures described, the various sub-colonies were maintained in isolation without further treatment. Their levels of resistance to a variety of insecticides were measured, and the results are set out in the accompanying table from which the following conclusions may be drawn:

(1) Resistance to BHC and chlordane in the housefly seems to be quite independent of DDT-tolerance; changes in resistance to the first two do not affect the level of the latter, and vice versa. On the other hand, the factors for resistance to BHC, chlordane and dieldrin are linked together, so that selection for one of them raises the resistance to the others. Possibly a single defence mechanism copes with a range of these chlorinated compounds.

(2) Resistance to the paralysis caused by DDT is not rigidly linked with resistance to its lethal effect. These factors are experimentally difficult to separate, because one cannot select for knock-down without killing some of the flies. However, it will be seen that strains *I* and *S* have about the same levels of resistance to the lethal action of DDT and so have strains *Ch* and *SS*; but the members of each pair differ considerably in resistance to paralysis.

(3) Something must now be said about the compound described as 'DANP' in the table, which is 1,1-dianisyl-neopentane. The preparation and properties of this compound have been described by Brown and Rogers[2], of the Merck Company, U.S.A., to whom I am indebted for supplying a sample. This compound is similar to DDT, but contains no chlorine; it has the *p*-chlorine atoms replaced by methoxy groups and the —$CCl_3$ group changed to —$C(CH_3)_3$. Therefore it cannot be degraded by dehydrochlorination to the non-insecticidal ethylenic body; which process appears to be one type of protective mechanism in DDT-resistant houseflies.

On inspection of the results in the table, it will be seen that resistance to paralysis by DDT is correlated with resistance to dianisyl-neopentane and to

Resistance characteristics of certain strains of houseflies ('DANP' is dianisyl-n entane; see text)

| Strain | Derived from | Med. leth. conc. (%) DDT | Knock-down by DDT (%) ½ hr. | Knock-down by DDT (%) 1 hr. | Medium lethal concentrations (%) 'DANP' | Pyrethrin | γBHC | Dieldrin | Chlordane |
|---|---|---|---|---|---|---|---|---|---|
| *N* | Rome | 0·07 | 95 | 100 | 0·90 | 0·07 | 0·006 | 0·006 | 0·04 |
| *N.S* | *N* × *S* | 0·08 | 96 | 100 | 0·75 | 0·08 | 0·06 | 0·1 | 0·8 |
| *S* | Sardinia | 1·8 | 88 | 100 | 0·85 | 0·06 | 0·05 | 0·3 | 2·8 |
| *I* | Italy | 1·7 | 30 | 50 | — | 0·35 | 0·005 | 0·007 | 0·038 |
| *SS* | *S* | 3·7 | 66 | 93 | 1·1 | 0·10 | — | — | — |
| *Ch* | *I* | 3·8 | 50 | 59 | 6 | 0·32 | 0·3 | >1·8 | 20 |
| *P* | *I* | 5 | 17 | 39 | 7 | 0·6 | 0·006 | 0·004 | 0·05 |
| *S.k-d* | *S* | ⩾5 | 0 | 0 | ⩾10 | 0·8 | 0·03 | 0·22 | 1 |

pyrethrins. This is an extension of my 1951 observations that the paralysis-resistant strain *I*, which was also resistant to pyrethrins, was indifferent to the case of dehydrochlorination of DDT analogues; thus contrasting with strain *S*. It seems clear that there is a DDT-resistance factor not concerned with dehydrochlorination, and it appears that this factor is associated with resistance to DDT-paralysis and kill by pyrethrins.

### DDT-resistant Body Lice

The report of DDT-resistance in Korean body lice[3] re-awakened our interest in alternative insecticides for control measures. Body lice are unpleasant to rear continuously, and we had allowed our culture at the London School of Hygiene and Tropical Medicine to lapse. Some difficulty was experienced in obtaining a new colony, until Dr. S. Madwar kindly sent some eggs by air from a strain kept at the laboratory of the Insect Control Section of the Ministry of Public Health, Cairo. This strain was maintained and expanded here and was used for testing new synthetic insecticides.

Results of comparative tests, however, suggested that these lice possessed undue resistance to DDT. Thus, spray tests indicated a median lethal concentration nine times as high as that obtained with the same technique in 1946[4] using susceptible British lice, whereas the dose for γ-benzene hexachloride was only 1·3 times as great. To confirm the earlier observations, another susceptible colony was started, from an infested man in London, and tested side by side with the Egyptian lice.

A range of new insecticides was then tested against the new DDT-resistant strain. Batches of the lice were exposed for a standard period (18-hr.) at 30° C. on filter papers impregnated with 3 mgm. per sq. cm. of oil solutions of different concentrations. From the resulting mortalities, median lethal concentrations were determined as follows: DDT $\geqslant$ 3 per cent (susceptible lice 0·6 per cent); γBHC 0·025 per cent; chlordane 0·12 per cent; dieldrin 0·018 per cent; aldrin 0·04 per cent; toxaphene 0·6 per cent; allethrin 0·74 per cent; pyrethrins 0·14 per cent.

From these figures, it appears that lice of this colony are normally susceptible to insecticides other than DDT. Tests with dianisyl-neopentane gave a median lethal concentration of 2·5 per cent for the susceptible colony, whereas none of the Egyptian colony was killed by 10 per cent. Therefore, the resistance cannot be accounted for by a dehydrochlorination mechanism.

*Origin of the resistant strain.* Insecticide-resistant strains of pests are usually 'developed' by widespread use of a particular insecticide, which kills off the susceptible individuals and allows the resistant ones to proliferate. A possible reason for the DDT-resistance of the strain from Cairo is that the Egyptian Ministry of Public Health had undertaken vigorous campaigns of DDT-dusting of villagers in all districts for four years (1946–50) before the colony was started in the Cairo laboratory. Afterwards the lice were reared for two years in the absence of insecticide before the sub-colony was sent to me.

It is not possible to compare with precision the DDT-resistance of these lice with those in Korea without a detailed knowledge of the technique used by the American workers. However, it appears that the Korean lice were more resistant, because they were stated to pass their complete life-cycle on cloth impregnated with 0·1 per cent DDT in acetone. Fifty first-stage nymphs of the Cairo strain were placed on tape impregnated with this solution, and most of them died within five days, all being dead within twelve days.

*Acknowledgements.* I am grateful to Dr. C. M. Harrison for allowing me to experiment with flies from one of her cultures; and also to Dr. A. A. Shwarby for helping me to obtain and rear the lice from Cairo.

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[2] Brown, D. H., and Rogers, E. F., *J. Amer. Chem. Soc.*, **72**, 1864 (1950).
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## PERMEABILITY OF INSECT CUTICLE TO AQUEOUS STAINS AND VULNERABILITY TO INSECTICIDES

By S. MUKERJI and S. N. CHATTERJEE

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WIGGLESWORTH[1] showed that abrasion of the surface of the cuticle of an insect by inert dusts not only increases the permeability to water but also facilitates the entry of insecticides. Later[2], he showed, by the use of ammoniacal silver hydroxide, that the abrasion of the protective wax layer in beetles takes place chiefly at the points of articulation of the limbs but also, to some extent, at other points where the soft cuticle of the moving insect is rubbed against the dust or where the dusts get into the mobile joints. More recently, Slifer[3] used aqueous solutions of dyes (methylene blue, neutral red, fast green and crystal violet) to find out worn and abraded areas of the cuticle on the ventral walking surface of the legs, namely, the tarsus and pretarsus with their appendages. Slifer's studies in this direction indicated that the under-surface of the arolia of *Melanoplus differentialis* (Thomas) lacked the protective cement layer which elsewhere on the leg protects the waterproof waxy film present in the outermost layers of the cuticle. She thus concludes that, because of the absence of the cement layer, the wax on the ventral surface of the arolium is easily dissolved by wax solvents and the inner layers which remain then offer little resistance to the penetration of dyes and other substances. Slifer's observations thus lend support to the experimental results with insecticides made by Kennedy, Ainsworth and Toms[4]. By staining, with iodine, various parts of the body of *Locusta migratoria migratorioides* R & F., Slifer[5] afterwards obtained results which indicated a similar absence of the cement layer from other cuticular areas besides the arolia. So far, nothing is known about work on similar lines on other insects.

Using the cuticle as a whole of insects of different orders collected from Nature as well as bred in the laboratory, and following Slifer's technique, the reaction of aqueous solutions of various dyes was observed with the view of locating the areas permeable to stain which would, at the same time, react positively to an aqueous solution or wettable powder of some well-known insecticides. Thus, the use of a carrier oil was altogether avoided, so as to ascertain the degree of permeability of the aqueous solution or

| Name and stage of insects tested | Vulnerable areas | | | | | Non-vulnerable areas | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Areas with stain reaction positive with 0·1% aqueous solution of crystal violet | Areas with stain reaction positive treated with insecticides | | | | Areas with stain reaction negative or doubtful | Areas with stain reaction negative treated with insecticide | | | |
| | | Nicotine sulphate 0·3% solution | | 'Gammexane' 2·0% colloidal susp. in water | | | Nicotine sulphate 0·3% solution | | 'Gammexane' 2·0% colloidal susp. in water | |
| | | Mortality (%) | Time of action (hr.) | Mortality (%) | Time of action (hr.) | | Mortality (%) | Time of action (hr.) | Mortality (%) | Time of action (hr.) |
| *Athalia proxima* Klug Larva (Hymenoptera : Tenthredinidæ) Collected from Nature | (*a*) Ventral cervical shield | 20·0 | 24 | 98·0 | 24 | (*a*) Thoracic tergum (prothorax) | nil | | 16·6 | 24 |
| | (*b*) Dorsum of last abdominal segment | 10·0 | 24 | 100·0 | 24 | | | | | |
| *Pyrilla perpusilla* Walker. Adult (Hemiptera : Fulgoridæ) Collected from Nature | Ventral part of first tarsus of hind leg | 74·24 | 24 | 69·6 | 24 | (*a*) Mesothoracic tergum | 38·7 | 24 | 12·6 | 24 |
| | | Toxaphene 0·5% colloidal susp. in water | | | | | Toxaphene 0·5% colloidal susp. in water | | | |
| | | Mortality (%) | Time of action | | | | Mortality (%) | Time of action | | |
| *Schistocerca gregaria* Forskal (Orthoptera : Acrididæ) V stage nymphs (gregaria) bred in laboratory | (*a*) Membrane below metanotum | | | 90·0 | 24–76 | (*a*) Dorsum of metanotum | nil | | 16·6 | 24 |
| | (*b*) Above dorso-pleural line distal to spiracular openings (abdomen) | nil | | 100·0* | 20–48 | (*b*) Sternal intersegments of abdomen | nil | | 16·6 | 24 |
| | (*c*) Tarsi and pretarsi | | | 100·0 | 22–48 | (*c*) Ventro-pleural line (membrane) | | | 10·1 | 24 |
| Adults bred in laboratory | (*a*) Above dorso-pleural line distal to spiracular openings (abdomen) | | | 100·0* | 24–96 | (*a*) Thoracic sternite | | | nil | |
| | (*b*) Tarsi and pretarsi | | | 100·0 | 24–48 | | | | | |

* The fluid was absorbed in this region rapidly

suspension, as the case may be, of the toxic materials in a localized zone and their subsequent transference to the vital epidermal cells. Although different stain reactions were obtained with various types of insects, only the results of those which were tested with insecticides have been incorporated in the accompanying table. Of the four stains used, crystal violet was found to be the most penetrating reagent as it is most fat-soluble; a 0·1 per cent aqueous solution of this stain was therefore used as final indicator. In the case of *Schistocerca gregaria* Forsk., both freshly emerged (moulted forms) or older nymphs and adults were used, and there was but little difference in the reaction to stain or insecticide in the same stage of the insects tested. Older adults were, however, found to be comparatively more resistant to BHC. The wettable powder was applied to the parts with a positive stain reaction with a very fine brush and allowed to dry on the spot.

The results so far obtained indicate that for each type of insect the vulnerable areas react differently to different types of toxic materials used, that is to say, they are selective for positive reactions for different insecticides. The reaction is therefore dependent on the various physical properties of the insecticides involved, as well as on the morphological and chemical character of the cuticular components. The results further establish the fact that besides the areas of natural abrasion, which one of us (S. M.) is tempted to name 'ecoabrasion', other selective vulnerable areas are also present on the insect cuticle through which the absorption of a fatal dosage of the toxic materials in aqueous media may occur. Preliminary experiments indicate that in the case of the tarsi (with appendages) of freshly moulted adults, kept under conditions where there was least chance of abrasion, a high percentage of mortality was noticed after the superficial application of wettable BHC, whereas no death was observed when the compound was applied to the pretarsi.

Further work on this subject is in progress.

We are indebted to Prof. V. B. Wigglesworth (Cambridge) and Dr. E. H. Slifer (Iowa), respectively, for valuable advice. [April 18.

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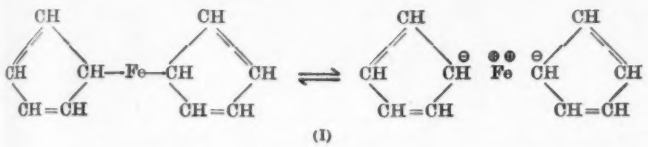
# LETTERS TO THE EDITORS

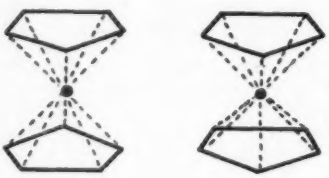
*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## *Bis-cyclo*pentadienyl Iron : a Molecular Sandwich

Kealy and Pauson[1] have described the preparation of *bis-cyclo*pentadienyl iron, $(C_5H_5)_2Fe$, which they formulated as (I). More recently, Wilkinson, Rosenblum, Whiting and Woodward[2] have observed that the compound is diamagnetic, that it has zero dipole moment, and that only one C—H stretching frequency occurs (at 3·25 $\mu$) in the infra-red absorption spectrum; on the basis of these observations they have proposed the very unorthodox structures (II) or (III). In the present communication we wish to present X-ray evidence for the correctness of (II) and also to interpret this unusual structure in terms of electronic structural principles.




(I)



(II) (III)

*Bis-cyclo*pentadienyl iron crystallizes from common organic solvents in a variety of forms, needles elongated along [110] and diamond-shaped plates bounded by {110} and {001} occurring the most frequently. The unit cell is monoclinic with cell dimensions, $a = 10{\cdot}50$ A., $b = 7{\cdot}63$ A., $c = 5{\cdot}95$ A., $\beta = 121°$, space-group $P2_1/a$ ($C_{2h}^5$), and contains two formula units of $C_{10}H_{10}Fe$. Each molecule must therefore possess a centre of symmetry occupied by the iron atom, which contributes either $+ 2f_{Fe}$ or zero to the structure factors according as $h + k$ is even or odd, so that the preliminary structure analysis may be carried out in a direct fashion.

The main features of the structure are apparent from the initial projections of the electron density on the (010) and (001) crystal planes. The function $\rho(xz)$ computed with all signs positive is shown in Fig. 1. Four of the five atoms in each *cyclo*pentadienyl unit are resolved, the fifth being obscured by the heavy iron peak at the origin. For $\rho(xy)$, all terms with $h + k = 2n$ have been taken as positive; of the other terms, only two, $F(210)$ and $F(120)$, are of any considerable magnitude and, since $F(110)$ is strong and necessarily positive, it follows from the relationship[3], $s(h) = s(h')s(h + h')$, that these two terms must have the same sign, which may be taken arbitrarily as either positive or negative. The function $\rho(xy)$ is shown in Fig. 2. The plane of the *cyclo*pentadienyl ring is almost normal to the projection

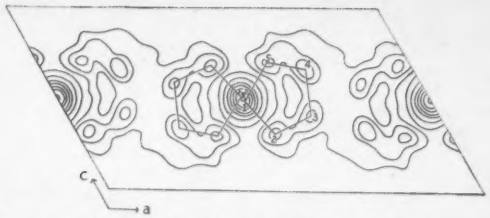



Fig. 1. Plot of function $\rho(xz)$. Contour lines are drawn at equal arbitrary intervals except for the iron atom, where the intervals have been increased by a factor of four for the sake of clarity

plane and the individual atoms are not resolved; but the general shape of the molecule is fairly obvious.

The two projections, considered together, leave no doubt that the 'sandwich' structure (II) proposed by Woodward *et al.* is correct. It is not yet possible to derive accurate details of the molecular dimensions and only a rough description can be provided at present. A molecular centre of symmetry is imposed by the space-group restrictions; but the appearance of the projections is reasonably consistent with a much higher molecular symmetry, $D_{5d}(\bar{5}m)$. Within rather wide limits of error, the C—C distance is about 1·4 A. and the C—Fe distance about 2·0 A.

A simple ten-bonded structure for $(C_5H_5)_2Fe$ is excluded, since only eighteen potentially bonding electrons are available and since, further, the set of iron orbitals of the correct symmetry cannot be formed using only $s$, $p$ and $d$ orbitals. A plausible formulation involving the resonance of a smaller number of bonds among the ten positions might be possible; but we have preferred to use molecular orbital theory.

The set of $d$-orbitals transforms in the group $D_{5d} = C_{5v} \times i$, according to the following scheme: $d_{z^2} \sim A_{1g}$, $d_{xz},d_{yz} \sim E_{1g}$, $d_{x^2-y^2},d_{xy} \sim E_{2g}$. The $\pi$-orbitals of the *cyclo*pentadienyl radical, according to simple molecular orbital theory, are $A_1$, $E_1$ and $E_2$ in order of decreasing stability. For two *cyclo*pentadienyl radicals oriented as in this molecule, each pair of orbitals can combine to give two orbitals transforming as even (gerade) or odd (ungerade) representations, for example, $2A_1 \rightarrow A_{1g} + A_{1u}$.

We assume that in the molecule the pair of *cyclo*pentadienyl radicals has the configuration

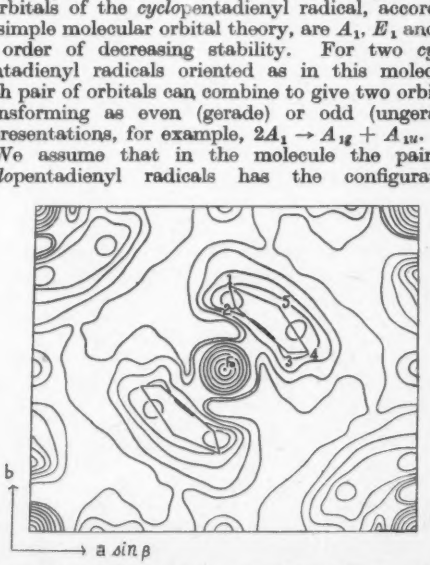



Fig. 2. Plot of function $\rho(xy)$. Contour intervals as in Fig. 1

$(A_{1g})^2(A_{1u})^2(E_{1g})^2(E_{1u})^4(E_{2g})^0(E_{2u})^0$ and the iron atom the configuration $(A_{1g})^2(E_{1g})^3(E_{2g})^4$. It will be seen that formally we may form two 'covalent-ionic' bonds using the $E_{1g}$ orbitals on the two parts of the molecule and also two 'donor' bonds in which the $E_{2g}$ electrons of the iron atom are able to spread into the empty $E_{2g}$ *cyclo*pentadienyl orbitals. (Although the σ-orbitals of the pair of *cyclo*pentadienyl radicals transform in the same way as the π-orbitals, they will not contribute to the bonding, since (1) the bonding orbitals are fully occupied and too strongly bound to lose electrons to the iron atom, and (2) the antibonding orbitals will be much less stable than the empty π-orbitals and hence will not behave as acceptors in the formation of 'donor' bonds.) The diamagnetism of the compound follows from the coupling of the four previously uncoupled $E_{1g}$ electrons.

The *cyclo*pentadienyl radicals will presumably acquire a negative charge as a net result of the two types of bond formation. The numerical value of the bond energy and the extent of the charge transferred cannot be calculated by methods at present available. We can, however, make some predictions as to the stability of *bis-cyclo*pentadienyl compounds of the other transition metals. Manganese and chromium, with sufficient donor and acceptor orbitals available, should form compounds of the same order of stability as that of iron. The cation $[(C_5H_5)_2Fe]^+$, which has been isolated as the tetrachlorogallate and picrate[3], is exactly analogous to the manganese compound. Nickel, with the configuration $(3d)^{10}$, has no orbital available for covalent bonding, while cobalt has only one orbital available. In both cases, therefore, we expect the compound to be much less stable than that of iron. Another possible stable compound, however, is the cation $[(C_5H_5)_2Co]^+$, in spite of the instability of the corresponding cobaltous complex.

Work is being continued with the view of obtaining a more precise description of this unusual molecule. We should like to thank Dr. H. M. E. Cardwell for preparing a sample of *bis-cyclo*pentadienyl iron for us.

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## Daily Variation of Meson Intensity and its Possible Solar Origin

The variation of meson intensity with solar time has been studied at Ahmedabad (mag. lat. 13° N., altitude 50 m.) and at Kodaikanal (mag. lat. 1° N., altitude 2,343 m.) with vertical triple-coincidence Geiger counter telescopes of narrow aperture with 11 cm. of lead. Observations at Ahmedabad with two similar independent telescopes extend over a period of two years, while at Kodaikanal with four independent telescopes they extend over a period of five months. Elaborate precautions were taken to keep experimental conditions very constant, and the results of independent but simultaneously operated telescopes at each place were similar. The intensity at each place was determined from hourly photographs of the mechanical recorders. For the purpose of the solar daily variation, the bi-hourly values of intensity were considered.

The solar daily variation of meson intensity is predominantly diurnal at Kodaikanal with an amplitude of 1·1 per cent. At Ahmedabad it has an amplitude of only 0·4 per cent with an important semidiurnal component as well. Figs. *A* and *B* show on 24-hr. and 12-hr. harmonic dials respectively the diurnal and semidiurnal harmonic components of the meson intensity $M_A$ and $M_K$, the atmospheric pressure $P_A$ and $P_K$ and the ground temperature $\theta_A$ and $\theta_K$ at Ahmedabad and Kodaikanal. The diurnal and semidiurnal components are indicated by the additional suffixes *D* and *S* respectively.

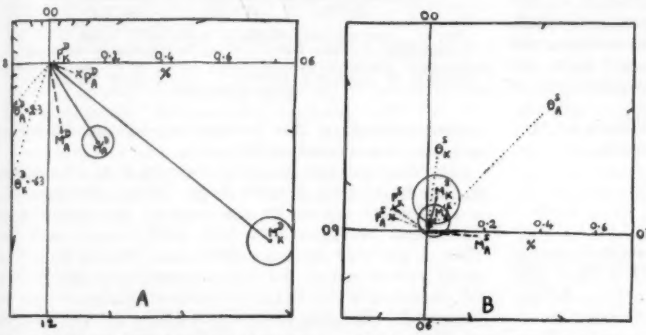
At low latitudes the periodic daily variations of $P$ and $\theta$ are larger and more pronounced than the irregular day-to-day variations which are so marked at places in high latitudes. Also, at low latitudes the daily variation of atmospheric pressure is mainly semidiurnal and that of temperature is diurnal. As a result, the semidiurnal components $P_A{}^S$ and $P_K{}^S$ are predominant, whereas $\theta_A{}^S$ and $\theta_K{}^S$ are negligible. This fortunately provides a means of studying the effect of pressure on meson intensity independently of other meteorological factors. At Ahmedabad, $M_A{}^S$ and $P_A{}^S$ have a very high correlation of $-0{\cdot}96$, the pressure coefficient being $-1{\cdot}7$ per cent per cm. mercury, in agreement with the mass absorption coefficient for mesons observed by other workers from day-to-day variations of intensity. At Kodaikanal, on the other hand, this correlation is only $+0{\cdot}29$. As, however, $M_K{}^S$ itself is only 0·12 per cent in amplitude and is not significant, this positive value might be fortuitous. The absence of the usual mass absorption coefficient indicates that during the atmospheric oscillations at Kodaikanal opposing factors act on $M$, and mask this absorption effect. These could be changes in heights of levels of meson formation or perhaps a density effect near these levels. An interesting feature of the present results is that, even near the equator for a high-level station, there is no marked semidiurnal variation of meson intensity positively correlated with pressure.

The atmospheric pressure plays an important part in the solar daily variation of mesons at the low-level station at Ahmedabad, but produces a negligible effect at Kodaikanal. The correlations of $M_K$ with $\theta_K$ and of the pressure-corrected meson variation $M'_A$ with $\theta_A$ are negligible. Ground temperature has therefore negligible effect at both places.

The curve of the residual meson variation corrected for pressure at Ahmedabad and the meson variation curve at Kodaikanal are both significant and strikingly similar. Both are diurnal with amplitude $M'_A = 0{\cdot}33 \pm 0{\cdot}06$ per cent and $M_K = 1{\cdot}1 \pm 0{\cdot}08$ per cent with maxima at 0950 and 0840 hr. local time respectively. It is unlikely that these variations are caused by a positive temperature effect such as is found by Duperier from day-to-day variations of mesons. Apart from the maxima being much earlier than the time at which a maximum of temperature in the upper atmosphere would be expected to occur, the amplitude of the diurnal temperature variation at the 200-mb. level is, on existing meteorological evidence, totally insufficient to account for a variation of meson intensity of 1·1 per cent as found at Kodaikanal. Variations of geomagnetic field are also not capable of explaining this variation.

There are thus grounds for believing that the observed diurnal variation of $M$ is caused by an

anisotropy of the primaries and is therefore extra-terrestrial in origin. The greatly reduced amplitude as well as a shift of maximum towards later hours at Ahmedabad when compared with Kodaikanal appears to be connected with the change of altitude between the stations. This is also seen in the ionization chamber results obtained at Huancayo as compared to the lower-level stations operated by the Carnegie Institution[1]. The amplitude of variation observed with our narrow-aperture Geiger counter-telescopes is larger than the omnidirectional ionization chamber results, as is to be expected. The increase of the percentage amplitude with elevation suggests the contribution of a larger number of low-energy particles which can make their effect felt at a high-level station but not at a sea-level station.




Amplitudes and hours of maxima in local time of harmonic components of meson intensity, atmospheric pressure and ground temperature variations. (*A*) 24-hr. harmonic dial; (*B*) 12-hr. harmonic dial

Since the variation is believed to be extra-terrestrial in origin, and the hour of maximum occurs at about the same local time during daylight hours throughout the year, a solar origin of this variation is suspected. The possibility of a part of the cosmic radiation originating from the sun, as deduced here from the nature of the residual diurnal variation of mesons, is supported by the occasional large increases in cosmic-ray intensity associated with solar flares, by recent observations associating variations of cosmic-ray neutrons with solar prominences, and by the large diurnal variation of the star intensity in the upper atmosphere reported by Lord and Schein[2]. Riddiford and Butler[3] have recently described processes by which particles from the sun can be accelerated to cosmic-ray energies. A close study of the occurrence of the hour of maximum under different conditions of observation of cosmic-ray intensity would throw a great deal of additional light on this subject. We hope to present shortly more data concerning this.

We are indebted to the Atomic Energy Commission of India for supporting this project. We are grateful to Prof. K. R. Ramanathan for many valuable discussions, particularly concerning the meteorological aspects of the problem.

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## Improved α-Track Autoradiographs of Biological Specimens

The use of Eastman Kodak nuclear track plates, type *NTA*, in the autoradiographic study of tissue containing thorotrast has been described previously[1]. Autoradiographs of this type are made as a matter of routine by floating a paraffined tissue section on to a photographic plate. However, during the floating and subsequent contact with wet emulsion, some of the radioactive material is leached out. Moreover, the large opaque clumps of thorium deposits in the tissue make counting of α-tracks in the underlying emulsion difficult.

The difficulties can be surmounted when liquid emulsion is poured over the section. This technique has been applied by Leblond and co-workers[2] and further improved by Bélanger[3], who described the 'inverted autograph' in which the tissue–emulsion complex is inverted and stained after processing. The 'inverted autograph' is of great advantage in the work with transparent sections, but observation of an autograph through tissue containing opaque substance is unsatisfactory. An attempt was therefore made to repeat the inversion process prior to final mounting for microscopic inspection.

The Ilford *G* 5 emulsion which is available in the gel form was applied. The conditions adopted were as follows: the emulsion was liquefied at 42° C. and poured over the deparaffined section on a prepared glass slide at approximately 40° C. The emulsion was dried by means of an air stream and stored in a 5-cm. lead shield inside the refrigerator. The *G* 5 emulsion was processed with an amidol developer and required an acetic acid stop-bath prior to fixing. When fixation was almost concluded, hardener was added. Inversion was done after washing, and the tissue–emulsion complex was allowed to dry on the new slide before staining. Since staining involves re-swelling and subsequent drying, an effort must be made to keep the emulsion from wrinkling. It was found advantageous to cut off excess emulsion at a distance of a few millimetres from the edge of the tissue section immediately before re-inversion. The difficulties in obtaining a plane tissue–emulsion complex which will adhere smoothly to a glass slide after re-inversion were minimized when the thickness of the processed emulsion was well below 100 microns. Since the maximum range in emulsion of the α-particles from thorium and its decay products is about 45 microns, the emulsion layer need not be thicker than that range.

The re-inverted autoradiographs give a clear picture of the distribution of the α-emitter in the tissue. Counting and topographic co-ordination of tracks with their points of origin in the tissue is extremely easy, even where large clumps of deposits are present in the tissue. Leaching of the radioactive material during the histological fixation of the tissue cannot be avoided completely; but, with proper precautions, contamination by dissolved and redistributed radioactive material becomes negligible. Therefore, in this case, the method of freeze-drying offers little advantage.

The diffusion of thoron out of the section and into the emulsion during exposure manifests itself more strikingly in the poured *G* 5 emulsion than in the *NTA* plate. The emulsion over the tissue contains a multitude of thoron stars and, due to the favourable geometrical conditions, the probability for all four prongs of the thoron stars being visible is very high. Also, the associated β-particles show in the *G* 5 emulsion as tracks. Storage of the plates in a lead shield reduces the accumulation of electron background tracks considerably (about a factor of 50 after a 10-day exposure).

Experiments are in progress in which the same technique is being applied to tissue containing beta emitters.

This investigation was supported by the James Picker Foundation on the recommendation of the Committee on Radiology, National Research Council.

*Note added in proof :* Since this communication was submitted, a letter by Prof. L. F. Bélanger upon the subject and dated July 15 has been published in *Nature* of October 11, p. 625.

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June 14.

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## Abnormalities in the Ionosphere at High Latitudes

The object of this communication is to direct attention to some interesting features of the incidence of the abnormal ionization in the *E*- and *D*-regions of the ionosphere at high latitudes during periods of magnetic disturbance[1,2].

For convenience, we select for study types of storm disturbance which are easily identified in the tables of data circulated by ionospheric observatories : (*a*) Storm *E*, the dense form of abnormal *E* which is totally reflecting on frequencies high compared with the *E* critical frequency (for example, present above 6 Mc./s. or preventing observation of the *F*2 critical frequency) ; (*b*) storm *D*, the intense *D*-region ionization which attenuates high-frequency waves so that they cannot be received at vertical incidence on any frequency.

The variations of the frequency of occurrence of these phenomena with time and position are readily evaluated and are found to have very interesting properties. The polar region may be divided into three zones, in each of which the incidence of the phenomena varies in a fairly regular manner. The most important zone may be called the 'storm belt'. In this the disturbances are particularly frequent and intense and show very regular and coherent variations with longitude. This zone overlaps, but is probably not identical with, the zone of maximum auroral activity. The number and intensity of the *E*- and *D*-region disturbances decrease rapidly with distance outside the storm belt but are otherwise similar to those found in the nearest sections of the belt. In the 'polar zone', the diurnal variations of both phenomena are radically different from those found elsewhere, but are modified locally by the activity in the storm belt. It is interesting to note that the

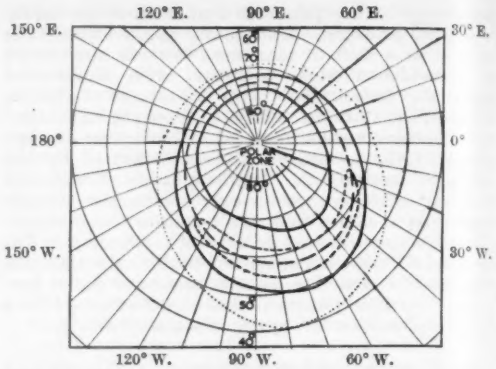


Fig. 1. Approximate position of main arctic zones : ———, boundaries of storm belt ; – – – –, boundaries of abnormally intensely disturbed part of storm belt ; — —, approximate position of maximum activity ; ……, outer boundary of polar quiet zone

characteristics of the fluctuations in the *F*2-region are also anomalous in this zone.

The diurnal variation of the storm *E* at all stations in the storm belt is very large. Thus, for example, over Canada about 80 per cent of the occurrences are found between 2000 and 0200 L.M.T., and less than 5 per cent between 0800 and 1600 L.M.T. The local time at which the diurnal maximum probability of occurrence is found is almost independent of longitude, changing from about 2100 L.M.T. in Sweden to 2300 L.M.T. in Canada. Thus the ionization behaves, approximately, as if it were generated in the classical manner by a stream of charged particles entering the ionosphere at a fairly constant angle relative to the direction of the sun. The diurnal maximum probability of occurrence of storm *E*, however, varies very greatly with longitude, reaching a large maximum near and over Canada. This change is particularly great for the most dense forms of storm *E* ionization which are practically confined to a sub-zone centred near Canada (Fig. 1).

The storm *D* ionization in the storm belt has quite different characteristics. The diurnal variation is less than that for storm *E* owing to the presence of occasional periods during which the ionization is present continuously for more than 24 hr. If these periods are omitted, the diurnal range becomes comparable to that found for the storm *E*, and most of the disturbances occur within ± 3 hr. of the maximum.

The time of maximum rate of occurrence near the centre of the storm belt varies in a most remarkable manner with longitude. The form of this varia-

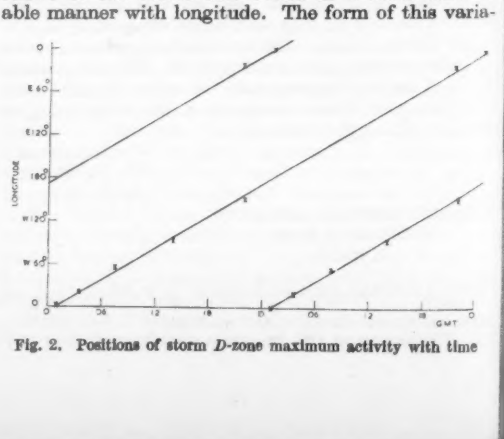


Fig. 2. Positions of storm *D*-zone maximum activity with time

tion may be clarified by plotting the longitudes at which it is found at different universal times (Fig. 2). As may be seen, the observed points, which are based on three years results in most cases, lie on a pair of straight lines separated by 180° (or 24 hr.), each of which repeats every 48 hr. Thus we can demonstrate the existence, at any instant, of two centres of activity on the *D*-region spaced 180° apart which rotate once around the earth every 48 hr. In contrast to the storm *E*, the probability of occurrence of storm *D* near the centre of the storm belt is almost constant throughout the western hemisphere between Sweden and Alaska.

The less intense forms of storm *D* perturbation, which do not completely attenuate all signals, have more complicated variations which combine the characteristics of the storm *E* and storm *D* perturbations discussed above.

An examination of individual disturbances shows that there is a close connexion between the areas affected by active *D* centres, *F*2-region perturbations and abnormally intense local magnetic activity.

The work described above was carried out as part of the programme of the Radio Research Board, and this note is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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## Insulin and the Permeability of Cell Membranes to Glucose

The effect of insulin in accelerating the peripheral utilization of glucose is generally ascribed to an action on the enzymic carrier system responsible for the intracellular oxidation of glucose, in which the first step is the hexokinase reaction.

More recently, evidence has accumulated suggesting that the locus of action of insulin may be, not on intracellular enzymes, but upon the transport mechanism whereby glucose is transferred across the cell membrane from the extracellular to the intracellular fluids. Such evidence is to be found in the work of Levine and his colleagues[1] on the effect of insulin on the distribution of galactose between the blood and the tissues, and in the effect of insulin in accelerating the rate of transfer of glucose across the blood-aqueous barrier[2].

This concept is further strengthened by studies on the uptake of glucose and other sugars by the isolated rabbit lens. Pairs of lenses immediately on removal from the eyes of anæsthetized rabbits were decapsulated and quickly weighed. They were then placed in tubes containing 3 ml. of Krebs–Henseleit–Ringer phosphate solution, *p*H 7·4, at 37° C. A sample of aqueous humour from one of these eyes had previously been removed by paracentesis and its glucose concentration estimated. Glucose was added to the medium so that its glucose concentration was identical with that of this aqueous humour. One unit of soluble insulin was added to one of the tubes, and both were incubated at 37° C. for 3 hr.; samples were removed from both tubes after 10, 60 and 180 min.

The mean uptake of glucose by the normal lens was 0·202 mgm./gm. lens substance/hr.; in the presence of insulin the uptake was 0·71 mgm./gm./hr. Insulin had thus accelerated the rate of uptake by 350 per cent. When homogenates of lens tissue were used, the rate of uptake of glucose was accelerated by only 33 per cent. When galactose was added to the medium and one hour allowed for equilibration, there was no uptake of galactose by the normal lens; but in the presence of insulin the uptake was 0·11 mgm./gm./hr. When sucrose was similarly employed, there was no uptake either in the presence or absence of insulin.

Insulin greatly accelerates the rate of glucose assimilation by the intact lens, but does so to a much less extent in homogenates in which the cell membranes have been broken down. Although the normal lens did not utilize galactose, nevertheless galactose is transferred into the cell in the presence of insulin; it is of interest to note that such lenses became opaque much more quickly than did lenses in the absence of galactose, suggesting that galactose blocks the glucose utilization mechanism. There is no specialized system for the transport of sucrose across the cell membrane, and hence insulin cannot promote the uptake of sucrose.

This work affords added support for the concept that an important action of insulin is to increase the permeability of cell membranes to biologically important sugars by accelerating an enzymic transport mechanism, and that in its absence such substances must enter the cell by solution in the cell membrane or by passage through 'pores'. The low lipoid solubility and high molecular weight of the sugars mean that their rate of entry by these routes would be slow, so that the organism, in the course of evolution, has developed these specific accelerator mechanisms to facilitate the entry of an adequate amount of glucose into the cell. The hyperglycæmia of diabetes mellitus is the result of the inability of glucose to enter the cells, rather than of a failure of intracellular enzymic oxidations. The intracellular oxidations essential for the life of the cell are maintained in diabetes mellitus largely by the utilization of 2-carbon-atom fragments obtained from the breakdown of fats, which are able to enter the cell because of their high lipoid solubility.

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## Histochemical Detection with Ditetrazolium Chloride of some Enzymatic Activities in Isolated Mitochondria

In an earlier paper[1], I have reported that ditetrazolium chloride, a substance introduced by Seligman and Ruthenburg[2] for the histochemical detection of succinoxidase in tissue sections, can also be used for the detection of the same enzyme in mitochondria isolated from kidney and liver. This has been recently confirmed by Schiebler[3] on the granula isolated from the neurohypophysis by differential sedimentation.

Oxidation of some Substrates by Rat Liver and Kidney Mitochondria as shown by the Reaction of Ditetrazolium Chloride (—, negative reaction; +−, very weak positive reaction; +, weak positive reaction; ++, positive reaction; +++, strong positive reaction; ++++, very strong positive reaction)

| Substrate added | Liver | | | | | | Kidney | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reading after | | | | | | Reading after | | | | | |
| | 30 min. | 1 hr. | 2 hr. | 6 hr. | 12 hr. | 24 hr. | 30 min. | 1 hr. | 2 hr. | 6 hr. | 12 hr. | 24 hr. |
| Sodium lactate | ++ | +++ | ++++ | ++++ | ++++ | ++++ | ++ | +++ | ++++ | ++++ | ++++ | ++++ |
| Sodium *dl*-malate | +− | + | ++ | ++ | ++ | +++ | +− | ++ | ++ | ++ | ++ | +++ |
| Sodium α-glycerophosphate | +− | + | + | ++ | ++ | +++ | + | ++ | +++ | +++ | +++ | +++ |
| *dl*-Alanine | +− | +− | + | + | + | ++ | + | ++ | ++ | ++ | +++ | +++ |
| *l*(+)-Alanine | − | − | − | − | − | − | − | − | − | − | − | − |
| Sodium glutamate | − | − | − | − | − | − | − | − | − | − | − | − |
| Tyramine | − | +− | +− | + | + | + | − | +− | +− | + | + | + |
| Hypoxanthine | − | − | − | − | − | − | − | − | +− | + | + | ++ |
| Sodium butyrate | − | − | − | − | − | − | − | − | − | − | − | − |
| Ethanol | − | − | − | − | − | +− | − | − | − | − | − | − |
| Glucose | − | − | − | − | − | − | − | − | − | − | − | − |

Since ditetrazolium chloride is an indicator for oxidation-reduction processes, an investigation was begun to determine if this substance could also be used for the histochemical detection of other enzymatic activities in isolated mitochondria.

Mitochondria were isolated from rat liver and kidney by Schneider's method. A small amount of the mitochondrial sediment was stratified on the interior surface of small tubes, and a mixture containing one part of ditetrazolium chloride (1 mgm. per ml. of distilled water), one part of physiological saline, one part of 0·01 *M* phosphate buffer solution (*p*H 7·4) and one part of the substrate solution was added until the final volume of 1 ml. was obtained. Control was made by omitting either the substrate or the colour solution. The tubes were then kept in a thermostat at 38° C. Readings were made after 30 min., 1 hr., 2 hr., 6 hr., 12 hr. and 24 hr.; when a blue colour was given, it indicated a positive reaction.

The following substrates were used, at the concentration indicated: sodium lactate 1 *M*, sodium α-glycerophosphate 0·2 *M*, sodium *dl*-malate 0·2 *M*, *dl*-alanine 0·2 *M*, *l*(+)-alanine 0·2 *M*, *dl*-glutamate 0·2 *M*, tyramine hydrochloride 0·25 *M*, sodium butyrate 0·2 *M*, glucose 0·2 *M*, ethanol 1 mgm., hypoxanthine 1 mgm. The results obtained are shown in the table. It was observed that the ditetrazolium chloride permits the histochemical detection in isolated mitochondria of lactodehydrogenase, of α-glycerophosphate dehydrogenase and of malic oxidase, which gave very strong positive reactions.

The reaction was also positive for *d*-amino-acid oxidase, oxidation of *dl*-alanine being more intense in kidney than in liver mitochondria. Very weak reactions were obtained for tyraminoxidase in both liver and kidney and for xanthinoxidase only in kidney mitochondria. The reaction was negative for alcoholdehydrogenase, glucosedehydrogenase, *l*-amino-acid oxidase and for the oxidases of glutamic and butyric acids.

The results obtained by this histochemical method agree with those previously obtained by manometric techniques on the localization in mitochondria of lactic dehydrogenase[5], α-glycerophosphate dehydrogenase[6], malic dehydrogenase[7] and *d*-amino-acid oxidase[8,9].

The negative reaction given by other enzymes, such as *l*-amino-acid oxidase and alcoholdehydrogenase, which were found to be present in mitochondria by other techniques, can be attributed to the low intensity of these enzymatic activities.

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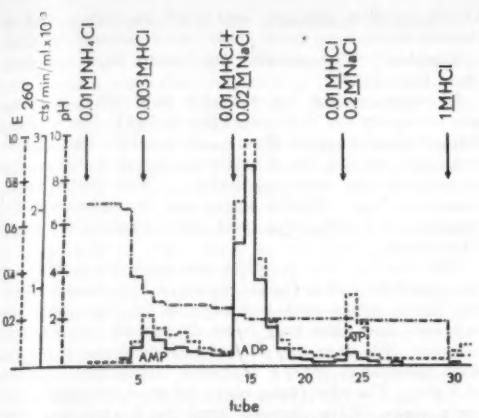
## Formation of Adenine Nucleotides from Adenine by Pigeon Liver Homogenates

Although the mechanism of the formation of inosinic acid from hypoxanthine[1] or glycine and formic acid[2], and the phosphorylation of adenosine to form 5-adenylic acid[3,4], have been studied in cell-free systems, the participation of adenine in nucleotide synthesis has received little attention. During an investigation of the pathway of incorporation of radioactive adenine into ribonucleic acid by *in vitro* systems in this laboratory, it was found that homogenates of pigeon liver were very active in the formation of acid-soluble adenine nucleotides within a short time.

In a typical experiment, 2·5 μ*M* of adenine-8-$^{14}$C hydrochloride[5] (containing 3·4 × $10^5$ counts/min. corresponding to 2·2 μC. carbon-14) were incubated at 37° for 20 min. with 15 ml. of a pigeon liver homogenate containing 2 gm. of tissue in the following medium: 0·13 *M* potassium chloride, 0·015 *M* potassium dihydrogen phosphate, 0·0046 *M* sodium bicarbonate, 0·0001 *M* sodium fluoride, 0·002 *M* magnesium sulphate brought to *p*H 7·1 with ammonia. The barium salts of the nucleotides were precipitated from the acid-soluble fraction at *p*H 8·2 in 80 per cent alcohol by the method of LePage[6]. A diluted solution of the regenerated barium-free nucleotides was brought to *p*H 5·6 and passed through a 'Dowex-1-chloride' column (3·5 cm. × 0·8 cm.²). The effluent contained an, as yet, unidentified substance which seems not to be identical with adenine, adenosine, 5-adenylic acid, adenosine di- or tri-phosphate. Further work is




Ion-exchange separation of adenine nucleotides from acid-soluble fraction after 20 min. incubation of pigeon liver homogenate with adenine-8-$^{14}$C

being done to determine the composition of this material, since in some experiments it contains a fairly large proportion of the original radiocarbon.

The column was then eluted according to the method of Cohn[7], as shown in the accompanying diagram, and 10-ml. fractions were collected. The *p*H extinctions at 260 mμ and carbon-14 were determined for each fraction and the results are summarized in the diagram.

It can be seen that the relatively small amount of adenine incubated with the tissue was mainly converted to the adenosine-5′-phosphoric acids. The identity of the adenosine monophosphate was confirmed by the differential enzymatic spectrophotometric method of Kalckar[8] with 5-adenylic acid deaminase prepared from rabbit muscle. All the absorption at 260 mμ was due to material which could be deaminated by the enzyme. The fractions marked ADP and ATP (adenosine di- and tri-phosphate) were similarly analysed by using a preparation of potato apyrase along with the 5-adenylic acid deaminase. While the adenosine diphosphate fraction reacted quantitatively with the enzymes, the content of adenosine triphosphate determined enzymatically was about one-half that indicated by the 260-mμ absorption. This may account for the lower relative count observed. It can be calculated that the activities of the adenosine mono- and di-phosphate correspond to a fourfold dilution of the original adenine.

The proportions and activities of adenosine mono-, di- and tri-phosphate vary considerably from one experiment to another, but the total counts found in the three nucleotides were usually 40–70 per cent of the initial carbon-14 added.

In another experiment the material which was not precipitable by barium and alcohol was analysed by paper chromatography; it was found to consist solely of labelled hypoxanthine with a specific activity corresponding to a sixfold dilution of the original adenine. A study of the formation of hypoxanthine as a function of time indicated that it is probably not derived directly from adenine, as has been suggested[9] for rabbit marrow slices.

The possibility that adenosine is the intermediate between adenine and adenosine monophosphate is now being investigated, as is the isolation of the enzymes responsible for the formation of 5-adenylic acid.

I wish to thank Dr. H. M. Kalckar for supplying me with the labelled adenine, and to acknowledge his stimulating criticisms and guidance. This work was performed under a fellowship of the American Cancer Society, Inc., recommended by the Committee on Growth, U.S. National Research Council.

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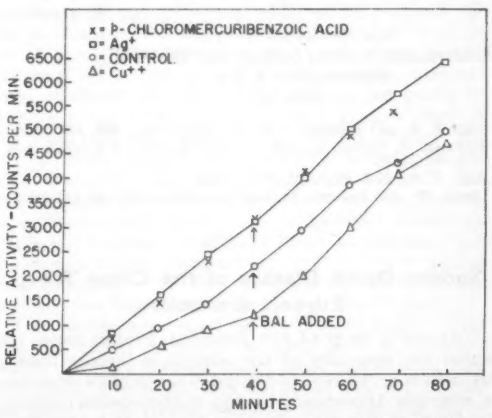
## Effect of Sulphydryl Reactants on Liver Ribonuclease

WHILE investigating the characteristics of rat liver ribonuclease it was noted that several reagents which react with sulphydryl groups increased the activity of this enzyme in homogenates. $4 \times 10^{-4}$ *M* silver or lead ions increased the activity approximately 25 per cent, while saturation of the test system with *p*-chloromercuribenzoic acid or phenyl mercuric chloride caused a similar increase. Cupric ion of $4 \times 10^{-4}$ *M* concentration was, however, inhibitory to the extent of 50 per cent. The inhibitory action of cupric ions could be reversed by the addition of 2,3-dimercaptopropanol (BAL); but this compound had no effect on systems containing the other sulphydryl reacting agents, or on the enzyme alone. The accompanying graph shows the results of a typical experiment.

The method of Roth and Milstein[1] was employed for the assay, and the control contained 10·0 ml. of veronal-acetate buffer of *p*H 7·75 and 0·17 *M* with respect to sodium ion; 2·0 ml. of 1 : 50 rat liver




Effect of sulphydryl-reacting agents on the activity of rat liver ribonuclease

homogenate and 3·0 ml. of distilled water. 1·0 ml. of 0·01 *M* lead chloride, silver nitrate or cupric chloride was substituted for 1·0 ml. of distilled water in separate flasks, while 10·0 mgm. of *p*-chloromercuribenzoic acid or phenyl mercuric chloride was added to other flasks containing the same components as the control. At zero time, 10·0 ml. of 1 per cent labelled yeast ribonucleic acid was added to each of the flasks, and after 40 min. 50 mgm. of 2,3-dimercaptopropanol was added to each. At 10-min. intervals, 3·0-ml. samples were withdrawn from the mixtures and to them was added 3·0 ml. of 1·0 *M* hydrochloric acid in 76 per cent ethanol. Blanks in which 2·0 ml. of water were substituted for the liver homogenate were run for each of the test systems. After addition of the acid-alcohol, the solutions were filtered and the radioactivity determined on an aliquot of the clear filtrate. The radioactivity of the blank filtrates was subtracted from the respective experimental filtrates to give the values shown in the graph. In general, the sulphydryl reactants had negligible effect on the substrate, although methyl glyoxal caused an increase in the acid solubility of the ribonucleic acid. This increase in acid solubility did not occur below *p*H 6, however.

Although other explanations are possible from the results obtained, it appeared likely that a sulphydryl-containing substance in liver homogenates was acting as a ribonuclease inhibitor, and that sulphydryl reactants could counteract this inhibition, at least in part. The anomalous action of cupric ions may be due to direct combination of this ion with the enzyme or substrate in preference to the inhibitor. As further evidence for the presence of a ribonuclease inhibitor in liver homogenates, it has been found that the sum of the activities of separate liver and kidney homogenates is greater than the activity of the same homogenates when mixed. Recently, Pirotte and Desreux have described an inhibitor for ribonuclease in guinea pig liver[4].

The presence of an inhibitor in liver which is absent from kidney might explain the considerably smaller ribonuclease activity of liver. The liver inhibitor may be heparin or a heparin–lipoprotein complex[2] which has been shown to contain cysteine, and it has been demonstrated that heparin is a potent inhibitor of ribonucleases[3]. Further work is in progress to determine the nature of these phenomena and their relation to cell division and growth.

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## Sudden-Death Disease of the Clove Tree, *Eugenia aromatica*

The clove crop of the Zanzibar Protectorate, on which the economy of the islands is largely based, and which provides nine-tenths of the world's supplies, is seriously threatened by the sudden-death disease. In 1950, it was estimated that at least half of the clove trees in Zanzibar Island had already been killed by this disease, and that in the island of Pemba there were more than two thousand separate outbreaks[1]. The disease has made rapid progress since that date.

An organization for research into clove diseases was set up by the Colonial Office in 1947. Preliminary field studies showed that sudden-death was almost certainly caused by a pathogen, and a virus was considered the most probable[2]. For three years, however, every known technique for revealing the presence of a virus was used with consistently negative results.

This led us, late in 1950, seriously to re-examine the possibility of a fungal cause, a hypothesis which had been considered unlikely, as it was generally believed that this had been disproved by previous workers. We then found that sudden-death is invariably associated with a hitherto undescribed species of *Valsa*. The absorbing roots die at a comparatively early stage of the disease, and the fungus can then be isolated from the distal parts of the root system. It can be found at the collar a week or more after death and afterwards spreads rapidly throughout the tree, producing an intense yellow colour in the invaded tissues. Extensive surveys have shown no instance of sudden-death where this *Valsa* was absent, and we have never found it in trees which have been killed by other agencies, such as fire, drought or severe dieback. Furthermore, we have failed to find any other fungus consistently associated with the disease.

Experiments have shown that *Valsa* can readily invade the tissues of mature clove trees, that young trees are comparatively resistant, and that seedlings are immune. Field experiments in which massive spore suspensions have been applied over a period of some months to uninjured roots of mature trees have demonstrated that the absorbing roots are attacked by the fungus, which later invades the fibrous root system, advancing in the cambial region, whence it spreads to other tissues.

Young clove saplings, between the ages of about eight and eighteen years, frequently suffer from a progressive decline over some years, accompanied by a root rot; this occurs in plantings in areas previously devastated by sudden-death and in which the old stumps are almost invariably left standing. We have found *Valsa* associated with this root rot, and consider the disease to be the symptom-expression of attack on young trees which are not yet fully susceptible to this fungus, and thus to be a form of the sudden-death disease.

It is not known how new outbreaks of sudden-death arise in previously disease-free areas, of which only a few still remain. We think it significant that in trees in these areas, as in the infected parts of the islands, *Valsa* can often be found acting as a wound parasite and causing a branch dieback.

Details of this work will be reported elsewhere.

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## A Freshwater Eel on Zanzibar Island

Playfair and Gunther's "Fishes of Zanzibar", 1866, bears a somewhat misleading title, for some of the species included come from places other than Zanzibar, some quite distant.

"Zanzibar" to-day means Zanzibar Island itself, whereas in earlier times the dominion and name extended over a wide area, including the coastal regions of East Africa. In consequence, creatures unknown from the Island itself have been recorded as occurring in "Zanzibar". One such is the freshwater eel, *Muræna mossambica* Peters, 1844.

Owing partly to the porous nature of the Island, there are few and restricted bodies of fresh water on Zanzibar, and there is only one run of water which merits naming as a river, and that disappears before it reaches the sea. The wide fluctuations in ocean-level during the Pleistocene would, in periods, have reduced the present Zanzibar Island to at most a group of islets, with almost certain extinction of most of the purely freshwater fauna of the more extensive lower drowned levels. During the recessions of the glacial periods some of this may have been restored; but there is no evidence that the larger rivers of the adjacent mainland flowed near Zanzibar. It is therefore not surprising that there is only a severely restricted freshwater ichthyfauna on the Island, only three or four species having been found there. In passing, it may be indicated that some of the recent wide fluctuations in ocean-level may well provide a clue to the explanation of at least some of the puzzling features in the land fauna of Mafia, Zanzibar and Pemba.

In current ichthyological literature, the freshwater eel is listed as occurring in Zanzibar. No less than three species, namely, *mossambica* Peters, 1844, *bengalensis* Gray, 1830, and *australis* Richards, 1841, are stated to be present in Zanzibar by Boulenger ("Freshwater Fishes of Africa", 3; 1915). These are apparently based on specimens recorded in Playfair and Gunther's "Fishes of Zanzibar" of 1866. A record of *mauritiana* Bennett, 1831, from Zanzibar by Weber and de Beaufort ("Fishes of the Indo-Australian Archipelago", 3, 247; 1916) is presumably based on the record of *A. johannæ* in Playfair and Gunther's "Fishes of Zanzibar".

Investigation reveals that none of the records is from Zanzibar Island itself, and so far as may be ascertained there is no authentic record of any species of freshwater eel having been found there. If the marine origin of the eels of this region be accepted, as they are found in the Ruvu and Pangani Rivers of the adjacent mainland, but for the accident that only comparative trickles of fresh water reach the sea from Zanzibar Island, it is surprising that no eels have ever been found there.

During a recent visit to investigate the fish life of the Zanzibar area, I inquired into the matter of the freshwater fishes, which have been investigated by several people during the past hundred years; but no further discoveries have been made in that period. Towards the close of my stay I learned that a large 'water snake' had been seen in a disused reservoir in which the lower "Chem-Chem" spring is completely enclosed; this structure is an unfortunate experiment by an engineer of earlier times, it is said, for he had failed to determine in advance the hydrostatic level of the source of the water. At my request the authorities kindly agreed to assist, and by means of a portable pump the water in this enclosed and roofed structure was reduced to a level where it kept pace with the restored flow through the porous coral rock. No life was visible in the considerable body of water remaining; but by means of an irritant chemical and nets, we soon captured the 'water snake', which proved to be a 30-in. well-nourished specimen of *Muræna mossambica* Peters, 1844, apparently the first to be known from Zanzibar Island.

This spring lies less than half a mile from the sea; but how the fish got into it is a mystery, as no water has ever flowed out of it, and the manholes in the roof of the enclosing structure have iron covers, supposed to have been kept closed for many years. It is just possible that a minute elver might have come through the eye of the spring, but not very likely in view of the absence of flow. The aliments in this specimen have not yet been examined, but its food can have consisted of little else than insects, and most likely of the smallest only.

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## Encapsulation in Rumen Bacterial Fractions

Methods of fractionating the rumen contents of sheep previously described in the literature (see, for example, footnote 1) involve centrifugation of uncooled, strained, rumen liquids at varying speeds on centrifuges running at room temperature. These procedures were found by us to be unsatisfactory for two reasons. First, during the time between collection and centrifugation of the liquids, the composition of the sample might alter as a result of bacterial fermentation and autolysis; and secondly, during the centrifugation, especially at high speeds, the liquids warm up to as much as 40° C., thus setting up convection currents in the centrifugate and causing fermentation with the liberation of gases which break up the sediments. We have found that these difficulties are overcome by the following procedure, which allows of fractionation on a small scale.

Rumen contents were collected through a permanent rumen fistula[2] by means of a wide-bore glass tube fitted with a rubber suction bulb, and immediately pipetted into a conical flask cooled in a freezing mixture of ice and salt, which reduced the temperature of the rumen contents to *c.* + 1° C. in 10–15 min. Further operations were then carried out in a cold room at + 1° C. The rumen contents were strained through a 60-gauge copper gauze to remove plant particles. (It is well to note that, if the fractions are required for cultural studies, the copper gauze should be replaced by bolting silk, as small traces of copper have a bactericidal effect.) The resulting liquid was centrifuged for 20 min. at 22,500 *g* in a 'Superspeed' head on a refrigerated centrifuge (M. S. E., London), conditions being adjusted so that the rumen liquid remained at + 1° to + 3° during centrifugation. If the temperature was further lowered, ice began to separate from the liquid.

Two sheep were used in the experiments. One was fed mixed concentrates (250 gm.) and potato starch (100 gm.), twice daily, with one feed of hay (250 gm.) in between, and the other was fed on hay (*ad lib.*). The rumen contents were sampled three hours after the morning feed. The samples from the starch-fed sheep were thick and formed four distinct

| Fraction No. | Appearance | Constituents |
|---|---|---|
| 1 | Brown opalescent liquid | Almost bacteria-free; few Gram-positive cocci and Gram-negative bacilli |
| 2 | White semi-solid layer | Almost entirely Gram-negative bacilli, cocci and vibrios; few Gram-positive cocci and bacilli |
| 3 | Fine green compact sediment | Protozoa, selenomonas and bacteria, as in fraction 2, plant particles and starch granules |
| 4 | Coarse material | Mostly plant particles, with some bacteria and protozoa |

fractions on centrifuging. These are described in the accompanying table.

Fractions 1 and 2 from the rumen liquids of the hay-fed sheep were similar to those from the starch-fed animal, but fractions 3 and 4 formed a single layer. The sediments were easily separated by repeated washing with a small volume of phosphate buffer (0·1 *M*; *p*H 7·0). A photomicrograph of a typical bacterial fraction (2) from the rumen liquids of a starch-fed sheep is shown in Fig. 1.

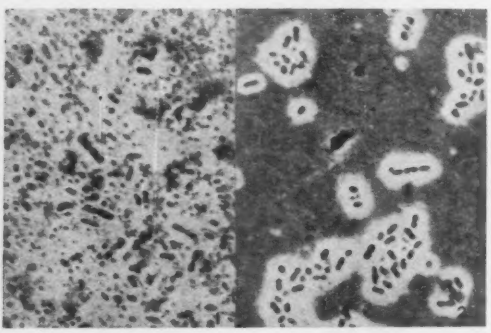

Fig. 1. Bacterial fraction 2 from a sheep on a starch-containing diet. Stained by Gram's method. × 1,500

Fig. 2. Bacterial fraction 2 from a sheep on a starch-containing diet. Wet Indian ink preparation, more dilute than Fig. 1, showing extensive encapsulation. Phase contrast. × 1,650

Examination of fraction 2 by Duguid's indian ink technique[3] showed that large numbers of the bacteria were heavily encapsulated, a fact which has not been noted in fractions prepared by the usual methods. The largest capsules, up to 9 $\mu$ in transverse diameter, were found on the bacteria from the hay-fed sheep. In the fraction from the starch-fed sheep large clumps of agglutinated bacteria surrounded by capsular material were seen. Moir and Masson[4] have recently described a survey of whole rumen contents, either fresh or incubated *in vitro* for one hour with glucose, in which they noted some encapsulated organisms. The present work suggests that encapsulated organisms constitute a large part of the bacterial fractions. This capsular material appears, from preliminary experiments on a strain of rumen streptococcus isolated in pure culture[5], to contain polysaccharide which, like the majority of the bacterial capsular materials so far investigated, does not stain with iodine. However, whether this capsular material can be utilized by the host animal at a later stage in the digestion cycle, as can starch-type intracellular polysaccharides[6], or can be converted by other bacteria into products of value to the host cannot yet be stated.

We wish to thank Dr. A. E. Oxford for interest shown in this work and for placing the hay-fed sheep at our disposal.

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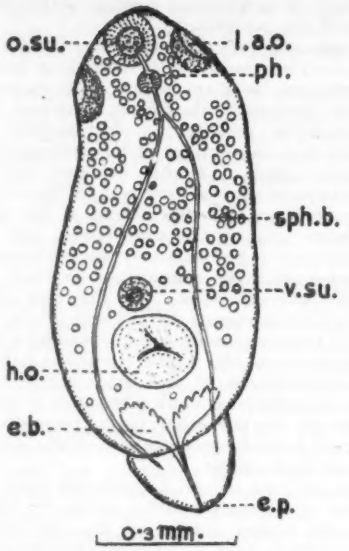
## A New Trematode Metacercaria from the Eyes of Trout

Several workers[1-4] have reported the occurrence of eye metacercariæ from various British freshwater fishes, and all have regarded their specimens as *Diplostomum volvens*. This, as described originally by Nordmann (1832) and reported later by various workers, has an oral sucker much smaller than the ventral, and its lateral adhesive organs are never in the form of cup-shaped structures. Moreover, its ventral sucker is also shown to be pre-equatorial in position. During an investigation on the trematodes of the brown trout, *Salmo trutta* L., at Edinburgh, I obtained, mostly from the vitreous humour of the eye, a metacercaria in which the oral sucker was much larger than the ventral, the lateral adhesive organs formed cup-shaped sucker-like structures and the ventral sucker was post-equatorial in position. It is, therefore, distinct from *Diplostomum volvens*. Furthermore, the present metacercaria on comparison comes nearer to some of the American and Australian species of *Diplostomulum* but differs from all these in several important features. It is, therefore, regarded as a new species and designated *Diplostomulum truttæ* n.sp. (*Diplostomulum* being the name given to eye metacercaria of which the adult has not yet been identified).

Its abbreviated specific description is as follows. The fore-body is large and the hind-body very small; at the lateral sides of the anterior end are deep cup-shaped sucker-like structures which can be protruded as ear-like lateral adhesive organs (*l.a.o.*). In a specimen of about 1·1 mm. length, the oral sucker (*o.su.*) measures 0·11 mm. in diameter and the ventral sucker (*v.su.*), which is post-equatorial and much smaller than the oral, measures 0·075 mm. in diameter. A short prepharynx leads into a globular pharynx (*ph.*), followed by a short œsophagus and two intestinal cæca extending into the hindbody. A well-developed holdfast organ (*h.o.*) lies posterior to the ventral sucker. Minute papillæ cover the body cuticle and a large number of spheroidal bodies (*sph.b.*) occur internally, especially concentrated in the middle third of the forebody. A well-developed bilobed excretory bladder (*e.b.*) opens postero-dorsally at the excretory pore (*e.p.*). In some living examples a number of longitudinal and transverse excretory vessels with about twenty-four flame cells could be made out.




*Diplostomulum truttæ* n.sp., showing body structures

This metacercaria is widely distributed in Scotland.

It is with great pleasure that I thank Prof. James Ritchie for providing me with facilities to carry out this investigation in the University of Edinburgh.

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## Growth and Axon Formation in the Midbrain of the Chicken Embryo

In the development of anterior horn cells, Hydén[1] recognizes three successive phases. The first is one of intensive growth without axon formation. In the second, growth is diminished, but axon formation occurs. In the third phase, growth is again intensive and associated with continued axon formation. The resulting peripheral axon can, in the adult, be regenerated by a 'revival' of this stage.

It is thus of interest to inquire whether equivalent phases occur in the development of nerve cells the axons of which remain within the central nervous system and which cannot regenerate. In the chicken embryo, such cells are found in the dorsal region of the midbrain vesicle which contributes to the corpora bigemina, and observations have been made on this region.

As in other parts of the central nervous system, axon formation cannot be demonstrated in the cells of the ependymal layer; but, in the earlier stages of development, these cells grow and divide rapidly and correspond to the first phase. However, when cells pass from the ependymal to the mantle layer, axon formation occurs. The developing axons accumulate in the more peripheral marginal layer, the width of which is, for a time, an indication of the amount of axon material formed by the mantle cells immediately underlying any particular region. Although this relationship becomes modified by the ingrowth and outgrowth of axons, the modification is not important before the eighth day of incubation. Hoadley[2] transplanted the three-day midbrain on to the chorio-allantoic membrane and, five days later, found that, although smaller than the controls, the transplanted midbrains had a normal architecture, achieved in the absence of ingrowing or outgrowing axons.

Since cell division does not occur in mantle cells, these would conform to the second phase if, while a significant amount of axon formation took place, there was little or no increase in cell size. The average volume of the cells was determined by counting the nuclei in measured areas of histological sections of known thickness. It was found that the volume of the mantle cells did not vary by more than $\pm$ 10 per cent in the period 3–8 days of incubation, although measurements of the diameters of the midbrain indicated an increase in its volume of more than a hundred times. In the same period the non-nucleated axon-containing layers increased from 2 to 40 per cent of the total width of the midbrain wall. Hence, in the period 3–8 days of incubation, mantle cells form axon material equivalent to about 40 per cent of their bulk without increasing in size, and thus conform to the second phase described in the development of anterior horn cells.

During the 3–8 day period, growth of the midbrain as a whole must be due to growth and division of cells in the ependymal layer. However, dividing cells disappear from this layer after the eighth day of incubation, so that subsequent growth of the midbrain can be assumed to require increase in size of individual cells. Further, these cells must continue to form axon material in order to make and maintain connexions with other parts of the central nervous system—a combination of growth and axon formation similar to that described above in the third developmental phase. Thus, the three phases occurring in the development of the anterior horn cells have their equivalent in the development of the cells of the midbrain, which, in contrast to the anterior horn cells, produce axons that do not leave the central nervous system and which are incapable of regeneration.

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## Neurosecretory Pathways in the Prawn, *Leander serratus*

Last year, I reported the presence of neurosecretory cells within the tritocerebral commissure of *Penæus braziliensis*, and the distribution of fuchsinophil droplets along the course of two post-commissure nerves[1]. Two flat extensions of these nerves, adjoining blood sinuses and therefore described as sinus-plates, were full of these droplets. Injection experiments showed that those regions with the most droplets yielded the most potent extracts when these were tested by their effects on the white chromatophores. The sinus-plates resemble the sinus-glands of the Mysidacea[2], and this parallel has been made

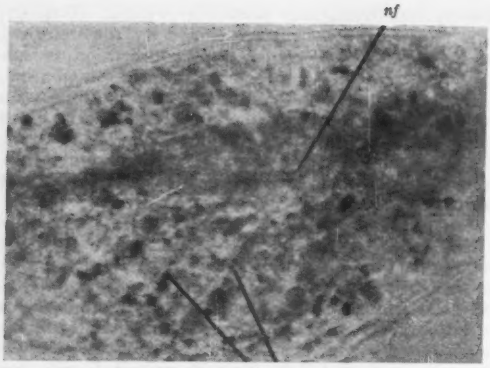


Fig. 1. The wide proximal portion of a post-commissure nerve

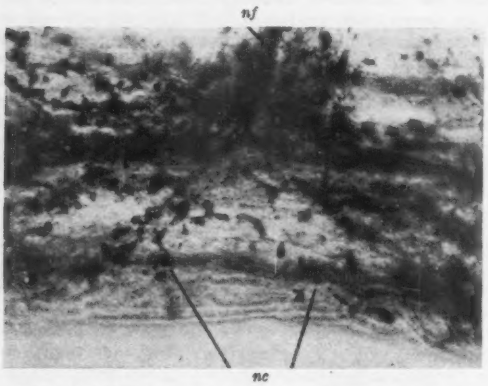


Fig. 2. The commissure at the base of a post-commissure nerve. *nf*, Position of nerve fibres in centre of post-commissure nerve; *nc*, lines of droplets marking the position of possible neurosecretory channels

more striking by the recent evidence of Enami[3], Passano[4] and others that the sinus-glands of some decapods are supplied by neurosecretory cells in the medulla terminalis; the secretory products pass along nerves and are released via secretory canals in the sinus-glands[2]. In the present experiments a search was made for secretory canals in the tritocerebral commissure and the post-commissure nerves of the prawn, *Leander serratus*. The nervous system was stained by a modification of the methylene blue method used by Alexandrowicz[5]; specimens were immersed in a solution of methylene blue for nine hours in a refrigerator.

Each post-commissure nerve of *Leander serratus* is broad and flat for the first half of its length. Nerve fibres lie along its centre and the remainder is filled by droplets which stain with methylene blue. These droplets are not dispersed at random but lie in lines, apparently along branched channels which radiate from the central fibres (Fig. 1). There is insufficient evidence at present to show whether these 'channels' are, in fact, axon fibres, though they seem to lie more superficially than the fibres, apparently within the tissue of the epineurium. Similar channels, marked by the position of droplets, radiate from the bases of the post-commissure nerves for some distance over the upper and the lower surfaces of the commissure (Fig. 2). Two slightly deeper channels extend from the bases of the post-commissure nerves to two large cells which lie in a median position within the hinder margin of the commissure.

One cannot ignore the possibility that the droplets which stain so readily with methylene blue are, in fact, artefacts, but I am inclined to consider them as secretory droplets for the following reasons: (1) they correspond in position to fuchsinophil droplets observed in serial sections of the commissure region of *Leander affinis*; (2) they are very numerous in the post-commissure nerves and in the commissure near by, but are sparse or absent in the rest of the commissure and in the connectives, and there is some degree of correlation between the concentration of droplets and the potency of extracts obtained from the different areas. The injection of extracts of the post-commissure nerves and of the adjacent region of the commissure was followed by a prolonged concentration of the white chromatophores and a brief concentration of the red chromatophores in normal and eyeless animals. Extracts of the nearby connectives, on the other hand, promoted only a slight and a brief concentration of the red and the white chromatophores.

Serial sections of the commissure have revealed evidence of secretory activity in the two large cells within the hinder margin of the commissure. It seems probable that a chromatophorotropin is produced by these cells, conveyed to the bases of the post-commissure nerves, and thence distributed, stored, possibly elaborated and released along channels in the epineurium of the commissure and that of the post-commissure nerves, the latter being especially important. This interpretation of the post-commissure nerves as reservoirs and distributors of material produced by secretory cells within the nervous system agrees with current concepts of the X-organ–sinus-gland relationship in crustaceans[3], the pars intercerebralis–corpora cardiaca system in insects[6], and the hypothalamo–hypophyseal system in vertebrates[7].

The work was done at the Stazione Zoologica, Naples, Italy.

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## A Growth-Inhibitor for Streptomycin-resistant Mutants in Dense Suspensions of *Brucella abortus* (Strain 19)

It was observed that when bacterial suspensions in broth were exposed to streptomycin in a concentration of 100 μgm. per ml. the survivors multiplied slowly after a prolonged lag phase[1]. It was also observed that, when bacterial suspensions containing 320–1,600 millions of *Brucellæ* per 10 ml. were exposed to streptomycin, then the resistant mutants appeared in them more frequently than in those containing 1,600–8,000 millions of *Brucellæ* in the same volume[1].

In order to determine whether the lower rate of appearance of resistant mutants in bacterial sus-

pensions of high density exposed to streptomycin was due to an inhibiting action of the dead bacteria on the survivors, the following experiment was carried out.

2-ml. portions of suspension of *B. abortus* (Strain 19) containing $6 \times 10^9$ micro-organisms and streptomycin were distributed into seven series of test-tubes and Erlenmeyer flasks containing varying quantities of trypticase-soy-broth with streptomycin (100 μgm. per ml.). The varying quantities of broth were 0, 2, 4, 6, 10, 18 and 38 ml.; the densities of the bacterial suspension varied, therefore, and were $3 \times 10^9$, $1{\cdot}5 \times 10^9$, $1 \times 10^9$, $7{\cdot}5 \times 10^8$, $5 \times 10^8$, $3 \times 10^8$ and $1{\cdot}5 \times 10^8$, while the bacterial population was the same in each sample ($6 \times 10^9$). Ten replicas were prepared from every sample of bacterial density. By plating and incubating the bacterial suspension with streptomycin-agar, it was determined that seven resistant mutants were present in 2 ml. among $6 \times 10^9$ micro-organisms, or one resistant mutant in a bacterial population of $8{\cdot}6 \times 10^8$. After 11, 14, 20 and 27 days, 0·05-ml. samples were removed from each test-tube and inoculated on to agar plates in order to determine whether resistant mutants had survived and multiplied. The frequency of their appearance from samples of different bacterial density is given in Table 1.

Table 1

| Bacterial density per ml. | Appearance of resistant mutants after an incubation of: 11 days | 14 days | 20 days | 27 days |
|---|---|---|---|---|
| $3{\cdot}0 \times 10^9$ | 0/10 | 2/10 | 2/10 | 8/10 |
| $1{\cdot}5 \times 10^9$ | 4/10 | 4/10 | 4/10 | 8/10 |
| $1{\cdot}0 \times 10^9$ | 8/10 | 8/10 | 10/10 | 10/10 |
| $7{\cdot}5 \times 10^8$ | 10/10 | 10/10 | 10/10 | 10/10 |
| $5{\cdot}0 \times 10^8$ | 10/10 | 10/10 | 10/10 | 10/10 |
| $3{\cdot}0 \times 10^8$ | 10/10 | 10/10 | 10/10 | 10/10 |
| $1{\cdot}5 \times 10^8$ | 10/10 | 10/10 | 10/10 | 10/10 |

Filtrates of recently prepared bacterial suspensions in streptomycin broth containing $3 \times 10^9$ *Brucellæ* per ml. did not delay the appearance of resistant mutants. But when these suspensions were kept four months at room temperature, filtered through Seitz filters, diluted and inoculated with $1{\cdot}5 \times 10^8$ *Brucellæ* per ml., the delay observed in the appearance of resistant mutants in replicas of five culture-tubes is shown in Table 2.

Table 2

| Concentration of the filtrate | | Appearance of resistant mutants after an incubation of: 6 days | 10 days | 15 days |
|---|---|---|---|---|
| Undiluted | | 0/5 | 2/5 | 2/5 |
| Diluted | 1 : 2 | 1/5 | 1/5 | 1/5 |
| | 1 : 5 | 2/5 | 3/5 | 3/5 |
| | 1 : 10 | 2/5 | 2/5 | 2/5 |
| | 1 : 20 | 3/5 | 4/5 | 4/5 |
| | 1 : 50 | 3/5 | 4/5 | 4/5 |
| | 1 : 100 | 3/5 | 4/5 | 5/5 |
| Control | | 4/5 | 5/5 | 5/5 |

This experiment shows that the inhibiting factor was liberated by autolysis from the bacteria which were killed by the action of streptomycin.

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## Additional Photoperiodic Response in Sheep

Hitherto most work on the photoperiodic behaviour of mammals has been related to their reproductive cycles[1,2]. Hammond, jun.[3], working with mink, was able to demonstrate an effect on the onset of moulting (correlated with new and more rapid growth of hair), when the animals were responding to photoperiodic stimulation by coming into œstrus.

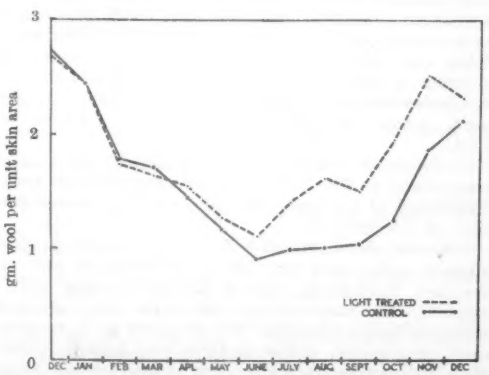
The general opinion among workers that the initial stimulus is received in the eye region and thence proceeds to activate the pituitary body in a gonadotrophic manner remains unaltered, although the exact sequence of events is not yet defined. In an attempt to elucidate further this exteroceptive stimulation of the pituitary body by light–dark sequence, experiments designed to test the nature of the response in sheep were commenced in January 1951. One important aspect of the question is, whether the stimulation is specifically a gonadotrophic one, or whether other hormones known to be elaborated by the pituitary are also involved.

Fourteen mature Corriedale ewes were randomized into two groups, and housed in individual pens in two adjacent rooms. The control group received solar light-rhythm by means of glass skylights in the roof and walls. The experimental group was housed in a blacked-out room and subjected to an artificial light-rhythm consisting of 8 hr. light–16 hr. darkness.

Exactly the same daily ration of concentrates and chaffed lucerne hay was allowed both groups during the experiment. Mean temperatures in the two rooms were approximately the same. All the ewes were mated, and at lambing in September were made to suckle twins if this did not occur naturally.

Monthly clippings from similar tattooed areas of skin were taken from both groups throughout the period. The accompanying graph shows the mean weight of clean scoured wool produced per month from these areas in the two groups.

In addition to wool growth, a study is being made of the photoperiodic effect on (*a*) the lactation curve of the ewes, (*b*) the composition of the milk, and (*c*) the growth-rate of the lambs. It is not possible at this stage to deal with all these aspects of the investigation, which is still in progress, but there is obviously a significant increase in wool-growth amounting to more than 15 per cent throughout the twelve months.




Mean weight of scoured wool

It is suggested that this may be due to the increased activity of the pituitary bodies of the light-treated animals, resulting in an increased output of either growth hormone or thyrotrophic hormone.

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## Transfer of Labelled Nitrogen from Glutamic Acid to Pine Seedlings through the Mycelium of *Boletus variegatus* (Sw.) Fr.

In a previous paper from this Institute[1] it was shown, by using the isotope technique, that hyphæ of *Boletus variegatus* (Sw.) Fr. in mycorrhizal connexion with pine seedlings transfer nitrogen from a solution of an ammonium salt to the roots. The labelled nitrogen was added as ammonium nitrate containing the stable isotope nitrogen-15 in the ammonium group. By a special arrangement, only the mycelium was exposed to the isotope, and then the amounts of nitrogen-15 were measured in different parts of the seedlings.

We have now studied in the same way the transfer of labelled nitrogen from an organic source to pine seedlings by means of mycorrhizal mycelium.

The nitrogen source chosen was glutamic acid. It has been recently demonstrated in this Institute[2] that the growth-rate of many mycorrhizal fungi is increased by certain amino-acids in a nutrient solution containing also ammonium-nitrogen. The growth-rate of *Boletus variegatus* is much increased, particularly by glutamic acid, under these experimental conditions. As a sole source of nitrogen, however, glutamic acid—in contrast to aspartic acid—yielded only a very poor mycelial growth. This seems to indicate that glutamic acid was not deaminated in any high degree by the fungus mycelium. Therefore, labelled glutamic acid seemed suitable for use as a tracer compound.

The experimental method used was as previously described[3]. In wide-necked 500-ml. Erlenmeyer flasks were placed cups near the wall. Both vessels were supplied with purified sand to which was added a nutrient solution containing ammonium phosphate as source of nitrogen. Into each of the Erlenmeyer flasks one aseptic seedling of *Pinus sylvestris* was introduced, and after some time mycelium of *Boletus variegatus* was inoculated in the cups. The cultures were grown during the spring and summer of 1951.

Glutamic acid labelled with nitrogen-15 was kindly synthesized by Dr. S. Wideqvist, Chemical Institute, University of Uppsala. It contained 6·3 atomic per cent of nitrogen-15.

When mycorrhizæ had become well developed, the labelled amino-acid was added to the glass cups in amounts of 50 mgm., that is, about 4·5 mgm. nitrogen. To the sand outside the cups were supplied corresponding quantities of unlabelled acid, to prevent, if possible, diffusion from the hyphæ. Half the cultures were harvested after one and a half days, the others after three days, of exposure.

The seedlings were divided into two sections, namely, (1) stem and needles, (2) the roots. The sections were then treated as previously described[4].

The measurements of nitrogen-15 were made by Dr. G. Ryhage, at the Institute of Chemistry, Stockholm. The mass spectrometer used was of the Nier type and gave a maximal error of 0·002 atomic per cent nitrogen-15 excess when the quantity of total nitrogen was 10 μgm.

In the accompanying table are given the values of the dry weights of the different sections, their total nitrogen content and the atomic per cent nitrogen-15 excess. It is clearly shown that nitrogen has been transported through the *Boletus* mycelium to the pine roots. From the mycorrhizal roots the isotope has further been translocated to the different parts of the seedlings. It may be difficult to prove that the nitrogen really has been delivered to the host tissues as glutamic acid. It may have been transaminated, at least in part, to other amino-acids already in the hyphal cells, and also have entered directly into the metabolic pathways leading to the synthesis of protein.

Atomic per cent Nitrogen-15 Excess in Pine Seedlings Grown in Mycorrhizal Connexion with *Boletus variegatus* exposed to Labelled Glutamic Acid

| Plant No. | Portion of seedling | Dry weight (mgm.) | Total nitrogen (mgm.) | Atomic per cent nitrogen-15 excess |
|---|---|---|---|---|
| | | 1½ days of exposure with the isotope | | |
| I | Stem | 97 | 2·98 | 0·010 |
| | Root | 39 | 1·16 | 0·034 |
| II | Stem | 103 | 3·11 | 0·010 |
| | Root | 49 | 1·43 | 0·036 |
| | | 3 days of exposure with the isotope | | |
| III | Stem | 109 | 3·30 | 0·013 |
| | Root | 52 | 1·62 | 0·059 |
| IV | Stem | 99 | 3·02 | 0·012 |
| | Root | 44 | 1·31 | 0·052 |

The experimental evidence leads to the assumption that nitrogen may be transferred to the root tissues through the *Boletus* mycelium from other amino-acids as well as glutamic acid. It may also be assumed that other mycorrhizal fungi of trees have the same ability as the fungus used in this experiment.

This investigation has been supported by a grant from Fonden för Skoglig Forskning, Stockholm.

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## Effect of Boron and Molybdenum Fertilizers on Berseem (*Trifolium alexandrinum*)

The cultivation of berseem, a leguminous forage crop, is gaining in importance in India on account of its high yields of succulent fodder of excellent nutritive value. Phosphatic fertilization of this legume has been found to be very beneficial[1].

Brenchley and Thornton[2], Midgley[3], Naftel[4] and others have shown that boron is essential for proper

In any Vertical Column Strip Reading Downwards, the First Figure Stands for Total Fodder Yields of all the Cuttings in Maunds per Acre, the Second for Seed Yield in lb. per Acre, and the Third for *Bhusa* (Dry Haulms of Seed Crop) Yield in Maunds per Acre (1 Maund = 82·3 lb.)

| Treatment | Superphos. | | Rock phos. | | Ammophos. | | Ammon. sulph. | | Control | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 |
| Boron | 668<br>176<br>37 | 1,016<br>264<br>49 | 680<br>143<br>34 | 937<br>232<br>48 | 893<br>203<br>40 | 1,091<br>297<br>50 | 787<br>171<br>46 | 938<br>210<br>42 | 635<br>180<br>38 | 899<br>141<br>35 | 773<br>175<br>39 | 976<br>229<br>45 |
| Molybdenum | 669<br>169<br>37 | 1,048<br>241<br>60 | 737<br>163<br>35 | 1,013<br>228<br>50 | 902<br>242<br>39 | 1,118<br>263<br>62 | 770<br>153<br>34 | 962<br>193<br>42 | 660<br>167<br>42 | 915<br>127<br>34 | 748<br>179<br>37 | 1,011<br>210<br>50 |
| Boron + molybdenum | 639<br>145<br>35 | 945<br>214<br>45 | 691<br>128<br>33 | 914<br>207<br>43 | 881<br>172<br>37 | 1,030<br>215<br>44 | 754<br>163<br>40 | 878<br>167<br>37 | 638<br>165<br>33 | 853<br>117<br>29 | 721<br>155<br>36 | 924<br>184<br>40 |
| Control | 571<br>124<br>29 | 908<br>192<br>41 | 676<br>118<br>25 | 848<br>166<br>41 | 854<br>161<br>36 | 1,007<br>176<br>41 | 758<br>171<br>32 | 857<br>135<br>32 | 606<br>124<br>33 | 834<br>100<br>30 | 693<br>140<br>31 | 891<br>154<br>37 |
| Average | 637<br>154<br>35 | 979<br>228<br>49 | 696<br>138<br>32 | 928<br>208<br>46 | 883<br>195<br>38 | 1,062<br>238<br>49 | 767<br>165<br>38 | 909<br>176<br>38 | 635<br>159<br>37 | 875<br>121<br>32 | 724<br>162<br>36 | 951<br>194<br>43 |
| | Fodder yield in maunds acre | | | | Seed yield in lb./acre | | | | *Bhusa* yield in maunds/acre | | | |
| | Major element | | Micronutrient | | Major element | | Micronutrient | | Major element | | Micronutrient | |
| | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 | 49–50 | 50–51 |
| 'F' test significant at | 1% | 1% | Nil | 1% | Nil | 1% | 1% | 1% | Nil | 5% | 1% | 1% |
| C.D. at 1× | 93 | 82 | — | 28 | — | 69 | 28 | 22 | — | — | 5 | 5 |
| C.D. at 5× | 66 | 58 | — | 25 | — | 47 | 21 | 17 | — | 11 | 3 | 3 |

growth and development of legumes. It is known that, in symbiotic nitrogen fixation, molybdenum plays an important part[5–7]. In proper doses boron and molybdenum have been reported also to have increased the yield of red clover and lucerne[8,9].

The results of a field experiment laid out on the Indian Agricultural Research Institute Farm at Delhi to study the effects of these two micronutrients in conjunction with certain major-element treatments on berseem are reported here. This experiment has been in progress on the same field for the past two seasons, namely, rabi (winter) 1949–50 and rabi 1950–51. The treatments are: main plot (1) superphosphate, (2) rock phosphate, finely ground to pass through a 100-mesh sieve, (3) 'Ammophos', all three to supply 80 lb. of phosphate ($P_2O_5$) each per acre, (4) ammonium sulphate to supply as much nitrogen as contained in treatment (3), and (5) control or no major element. Sub-plot: (1) boron to supply 5 lb. of borax per acre, (2) molybdenum as sodium molybdate to supply 1 lb. of molybdic oxide per acre, (3) boron and molybdenum (combined) as in (1) and (2), and (4) control or no micronutrient element. The design is 'split plot' with four replications. Net plot size is 1/60 acre.

The 0–9 in. depth sample of the soil, a loam, had the following characteristics: organic carbon 0·34 per cent, total nitrogen 0·04 per cent, available phosphate (Dyer) 0·034 per cent, base exchange capacity (milli-equiv./100 gm. soil) 16·60, *p*H 6·7.

Among the observations taken on several plant characters during the cropping seasons, nodulation was found to be significantly influenced by both boron and molybdenum. Before leaving the crop for seed, in 1949–50 four cuttings and in 1950–51 five cuttings of fodder were taken. The accompanying table gives the consolidated yield figures for the two seasons.

It is interesting to observe from these two years results that boron and molybdenum exercised a significant influence on the fodder, seed and 'bhusa' yields of berseem. Statistical analyses of the yields of individual cuttings have shown that in the first season the major element fertilizers were significant up to the third cutting; but in subsequent cuttings they failed to attain statistical significance, while the micronutrients started to become significant from the fourth cutting onwards. In the second season, however, while the major elements were found significant only up to the second cutting, the micronutrients proved significant in all the cuttings. A possible explanation for this would be that, since the requirements of micronutrients are small for normal healthy growth, the quantity present in the soil at the start was enough for the first few cuttings. But as more and more fodder was removed, they started to become a limiting factor, and thereafter the influence of fertilization with micronutrient elements became well pronounced.

The possibility of using boron and molybdenum as fertilizers in conjunction with phosphates to obtain increased yields of leguminous fodder and seed on soil types similar to those of Delhi is therefore indicated.

Further work is in progress.

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May 24.

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Saturday, January 17

BRITISH MYCOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Scientific Papers.

## Monday, January 19

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. Thomas Martin: "The Faraday Manuscripts with a Word about Davy".

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. B. A. Kilby: "The Biochemistry of Schradan".

## Tuesday, January 20

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.15 p.m.—Mr. R. A. Hamilton, Dr. A. B. Stewart and Dr. W. F. Raymond: Papers on "The Manuring of Grassland".

ROYAL PHOTOGRAPHIC SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 3.30 p.m.—Mr. Bertram Sinkinson: "The Centenary of the Royal Photographic Society".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Measurements of Magnetic Permeability" (to be opened by Dr. A. J. King).

UNIVERSITY OF LONDON (in the Senate House, Malet Street, London, W.C.1), at 6 p.m.—Sir Godfrey Thomson: "The Geometry of Mental Measurement".* (Further Lectures on January 21 and 22.)

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. M. Pourbaix: "The Electrochemical Behaviour of Metals and Corrosion".

SHEFFIELD METALLURGICAL ASSOCIATION (in the Grand Hotel, Sheffield), at 7 p.m.—Annual General Meeting.

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Physiology of Athletes" (Chairman: Prof. A. V. Hill, F.R.S.; Speakers: Dr. C. G. Douglas, F.R.S., Mr. Roger Bannister and Prof. A. Hemingway).

## Wednesday, January 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. S. C. Harland, F.R.S.: "Plant Hormones" (Fernhurst Lecture).

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. V. Lindley: "Statistical Inference".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. D. Nisbet: "Family Environment and Intelligence".*

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the BRITISH GLIDING ASSOCIATION, in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Discussion on "Fair Weather Cumulus".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Annual General Meeting; Brigadier H. G. Smith: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Some Difficulties in the Teaching of Electrical and Mechanical Resonance" (to be opened by Mr. C. T. Baldwin and Mr. J. C. Oakden).

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the LONDON SECTIONS of the SOCIETY OF CHEMICAL INDUSTRY and the INSTITUTE OF METALS, at University College, Gower Street, London, W.C.1), at 6.30 p.m.—Dr A. C. Menzies: "Analysis of Metals by Spectroscopy".

WOOL EDUCATION SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7 p.m.—Prof. J. E. Nichols: "Improving the World's Wool Supply—The Role of the Biologist".

## Thursday, January 22

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. Cartan: "On the Calculation of Homotopy Groups".

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (in Room H.301, Colonial Office, Church House, Great Smith Street, London, S.W.1), at 5.30 p.m.—Dr. F. N. Woodward: "The Uses of Seaweed".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. Bergel: "Some Chemical Aspects of Normal Growth".* (Further Lectures on January 30 and February 6.)

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. R. P. Linstead, F.R.S.: "Discoveries Among Conjugated Macrocyclic Compounds" (Fedler Lecture).

INSTITUTE OF WELDING, NORTH LONDON BRANCH (in the Fyvie Hall, The Polytechnic, Regent Street, London, W.1), at 7.30 p.m.—Mr. W. V. Binstead: "The Joining of Aluminium and its Alloys".

UNIVERSITY OF LONDON (in the Swanley Hall, Wye College, Wye, Ashford, Kent), at 8.15 p.m.—Mrs. Jacquetta Hawks: "Our Primitive Beginnings".*

## Friday, January 23

ROYAL ASTRONOMICAL SOCIETY (joint meeting with the GEOLOGICAL SOCIETY, at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "The Magnetization of Rocks" (Chairman: Prof. C. E. Tilley, F.R.S.; Speakers: Dr. J. M. Bruckshaw, Mr. A. F. Hallimond, Mr. J. Hospers and Mr. S. K. Runcorn).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL OF THE MID-ESSEX TECHNICAL COLLEGE, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (January 23).

ASSISTANT SECRETARY (graduate of a British university, preferably in science or engineering, with some experience of industry) to the University Appointments Board—The Registrar, The University, Liverpool (January 24).

PHYSICIST—a knowledge of statistics desirable (Ref. A.335/52A), and a BIOLOGICAL CHEMIST—preferred, but chemist with analytical experience or biologist with interest in chemistry acceptable (Ref. F. 808/52A), at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effect of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (January 24).

PHYSICISTS at a Ministry of Supply Establishment, Aldermaston, for (*a*) research on methods of radiation measurements—knowledge of radiation physics desirable; (*b*) research on physical properties of radioactive materials—practical experience of electron diffraction work, or measurement of short time intervals using high speed oscilloscopes, desirable—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.336/52A. (January 24).

UNIVERSITY GRADUATE (preferably physiologist) as Research Student in the Birmingham and Midland Eye Hospital, Church Street, Birmingham, for work in connexion with hereditary ocular disease—The Secretary, Dudley Road Hospital, Birmingham 18 (January 24).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Principal, Heriot-Watt College, Edinburgh (January 26).

SENIOR LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 1).

ASSISTANT ENTOMOLOGIST at the Wattle Research Institute, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 14).

ASSISTANT LECTURER IN GEOGRAPHY—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (February 20).

LECTURER OR ASSISTANT LECTURER IN ZOOLOGY at the University, of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 23).

SIMON FELLOWSHIPS for advanced study or research in the Social Sciences—The Registrar, The University, Manchester 13 (March 1).

BIOCHEMIST (with a postgraduate degree in biochemistry and five years teaching experience) at the Lady Hardinge Medical College, New Delhi—The Secretary, Division 5A, Ministry of Health, Savile Row, London, W.1.

DIRECTOR AT THE NATIONAL COAL BOARD CENTRAL RESEARCH ESTABLISHMENT II, Isleworth, Middx, and a DIRECTOR OF EXTRA-MURAL RESEARCH, A (Physics, Chemistry and Engineering)—Sir Charles Ellis, National Coal Board, Hobart House, Grosvenor Place, London, S.W.1.

EXPERIMENTAL OFFICER at the Royal Aircraft Establishment, Farnborough, to co-ordinate technical data, development and approval of electronic valves for joint Services use—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.339/52A.

GRADUATES for positions in marine zoology and salmon research, in the fields of research on groundfish, salmon, marine mammals, herring and lobsters, and other commercial invertebrates—The Director, Newfoundland Fisheries Research Station, St. John's, Newfoundland, Canada.

HOSPITAL BIOCHEMIST (principal grade)—The Group Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton.

LECTURER IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

LECTURER IN SYSTEMATIC BOTANY AND ECOLOGY—The Secretary and Registrar, The University, Southampton.

METEOROLOGICAL ASSISTANTS by the Falkland Islands Dependencies Survey for service at Port Stanley—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28135.E.

PRINCIPAL SCIENTIFIC OFFICER at a Ministry of Supply Experimental Flying Establishment, near Salisbury, to lead a section responsible for the complete design and proving of aircraft test instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.341/52A.

SCIENTIFIC OFFICERS at Ministry of Supply Research Establishments in South-East England: EXPERIMENTAL PHYSICISTS (near Southend) with interest in light engineering or metallurgy (Ref. A. 279/52A), and THEORETICAL PHYSICISTS or APPLIED MATHEMATICIANS (near Sevenoaks)—experience in astrophysics useful for one post (Ref. A.280/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.